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NEW FERRY AND RAILROAD TERMINAL STATIONS.

FOOT OF WEST TWENTY-THIRD STREET, N. Y. CITY.

West Twenty-third Street in this city has within a very short period become one of the central ferry terminals for great railroad transportation companies, whose lines end on the west bank of the Hudson River at a point mostly opposite the lower portion of the Borough of Manhattan.

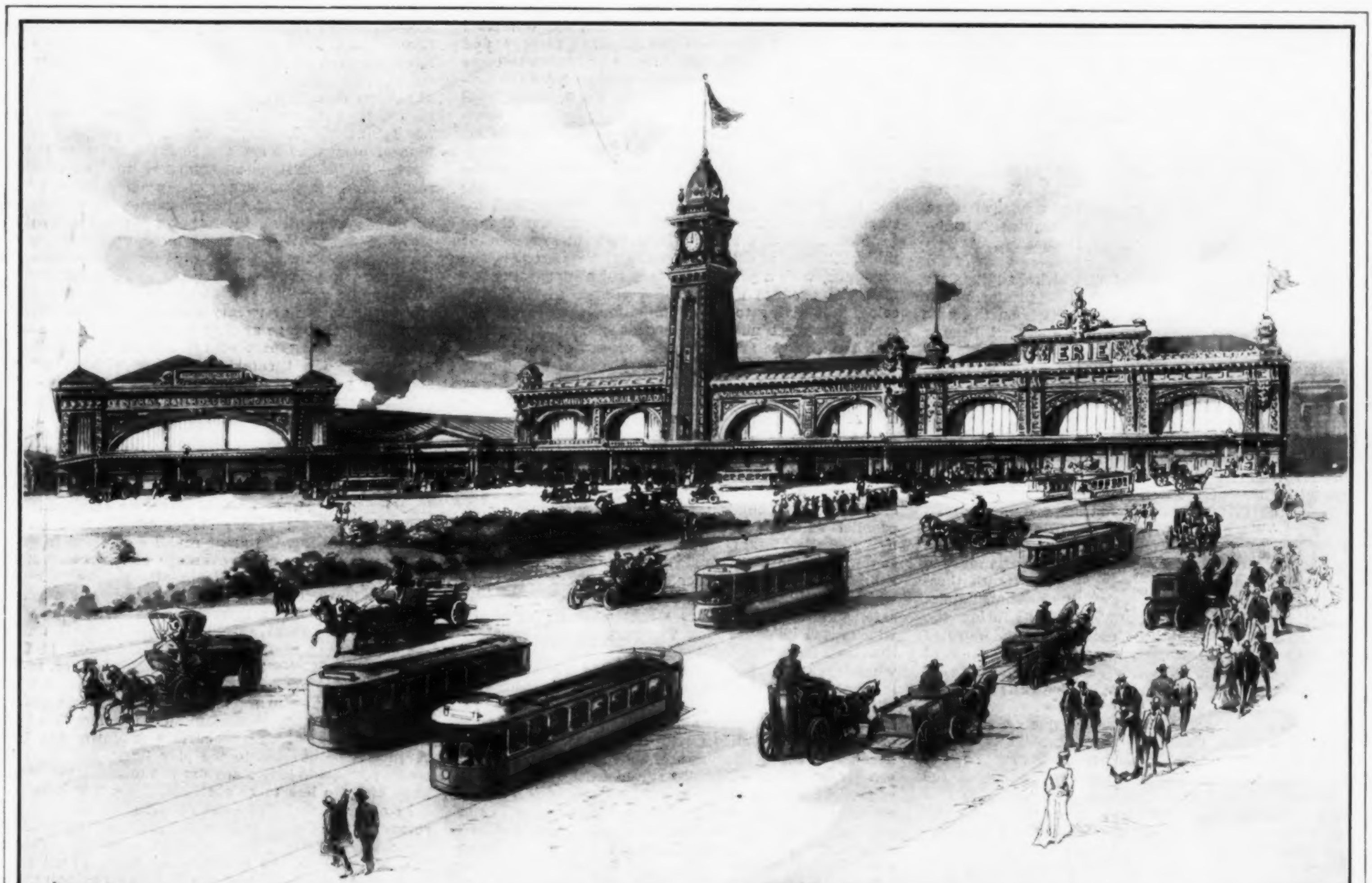
To accommodate the Central Railroad of New Jersey, the Lackawanna and Western Railroad, and the Erie Railroad, the new group of terminal ferry houses which the illustration shows is rapidly nearing completion, and is now partly occupied by two companies.

The architect of these buildings, Kenneth M. Murchison, and the engineer, Eugene W. Stern, had many difficult and vexing problems to solve in the designing and carrying out of the various parts, and not a small problem was the maintenance of traffic conditions during the period of construction. It is expected that the entire group of ferry houses will be fully completed during the coming fall.

The buildings are thought to be the largest and most imposing in their way of any in this country. The total frontage on the street is about seven hundred feet, the Jersey Central ferry house making a right angle with the Lackawanna building. The tower of the latter accentuates and gives prominence to the structures, while great electric signs will flash out their respective names both on the land and river sides.

The construction of these ferry houses is of the lightest possible description compatible with safety, for the river bottom at this point of the harbor consists of over a hundred feet of soft mud, and the piles on which the buildings rest sink imperceptibly until a settlement of six feet is reached, when the piles seem to assume a true bearing. This necessitates an elaborate system of jacks, one under each steel column, to compensate for the settlement of each column as it occurs.

The buildings are fireproof, and the whole exterior is covered with heavy copper, treated with acid in a combination of verdigris and statuary bronze tints.



GROUP OF RAILROAD TERMINAL FERRY STATIONS OCCUPIED BY ERIE, LACKAWANNA, AND NEW JERSEY CENTRAL RAILROADS AT THE FOOT OF WEST TWENTY-THIRD STREET, NEW YORK CITY.

[Concluded from Supplement No. 1541, page 24687.]

THEATRICAL ENGINEERING PAST AND PRESENT.*

Brandt, who had gone into the production of "Faust" with great enthusiasm, invented for it an epoch-making device, the truss bridge, which I will describe in some detail for the sake of clearness and on account of its importance. The iron truss bridges over streams, so light and airy and yet so strong, suggested to Brandt the construction of similar trusses of light wood for stage purposes. In the last scene of "Faust" the entire prison (represented by the back scene and arches) sinks below the stage and reveals the turreted roof of the prison, the distant city and a clouded sky to which Gretchen [Marguerite] is carried up from the prison in the arms of angels. This peculiar and complicated transformation scene, devised by Brandt, was made possible only by the truss bridge which enabled the heavy prison scenery with its roofs, turrets, and battlements to be suspended freely by invisible wires. At that time the Paris Opera was content to let the prison scene stand, merely darkening it and showing a brightly illuminated group of angels through the gauze back scene. By this comparison of the scenic devices used in Paris and Darmstadt I wish merely to show how differently the same problem may be solved, but by no means to detract from the fame of the Parisian artists of the period, to whom their foreign colleagues owed many valuable suggestions.

The theater directors of Europe naturally appropriated the sensational Parisian spectacles as quickly as possible, and flooded the large cities with them, in original or adapted form. In Berlin the Victoria theater was built expressly for performances of this sort, and Brandt, now famous for his production of "Faust" in some dozens of theaters, was intrusted with the construction of the stage. Thus Berlin acquired in 1860 a stage which, though based in principle on Muehldorfer's construction, comprised also many important novelties and improvements. Of course, the greatest possible care was devoted to the lighting, in which every advance yet made was utilized.

The indefatigable Meyerbeer had composed another opera, "L'Africaine," which was not performed until after his death. It was, of course, produced in Paris first, and mounted with especial care to serve as an attraction for the exposition of 1867. In addition to the well-known lighting effects of the fairy spectacles, it employed the valuable device called the optical cloud, which is still in use.

This apparatus, a modification of the magic lantern, had to be used in a darkened room, in order to produce an effective picture with the old and feeble sources of light, but the electrical apparatus devised by Duboscq for the artificial sun in "Le Prophète" made it possible, even with a fairly well-lighted stage, to project clouds painted on glass very satisfactorily upon a circular panorama representing the horizon. The flagship, which with its two cabins, deck, and bridge, filled the entire stage in the third act of "L'Africaine," and was mounted so as to move and turn, was con-

* An address delivered before the Polytechnic Club of Munich, January 9, 1905, by Carl Lautenschlaeger, formerly director of stage machinery at the Royal Bavarian Court Theater in Munich.

ceived by the composer as sailing toward the spectators, who were assumed to be aboard of it.

To produce this illusion two of these novel magic lanterns were concealed behind the bulwarks, to port and starboard, and the slides were so manipulated that the gleaming white clouds projected upon the deep blue sky on either side receded from the spectators, so that they and the ship appeared to be moving in the opposite direction.

The attractions of the fairy extravaganzas and spectacular operas could not, with all their splendor, satisfy a cultivated public indefinitely, and it seemed like a godsend when Richard Wagner's influence began to be felt—very slowly, at first—by the repertory. The drama, especially the classical drama, had lost almost all its attraction because of the niggardly way in which it was mounted, and it would have perished had not the talented Duke of Meiningen opened a new way to strength and popularity by his artistically perfect presentations.

The duke had followed, with the eye of an artist, the progress of stage management, and had appropriated to his use whatever appeared to him most effective. He had been particularly interested in the closed scenes, lately introduced from Paris, which at last made it possible to represent private rooms on the stage in a natural manner. To this improvement the duke and his artists added a transfiguration of stage pictures, which exerted a lasting effect upon all other theaters. Although a great many playhouses were built in Europe after the erection of the Victoria theater in Berlin in 1860, no essential advance in stage arrangement appeared until after 1880.

The new system of stage construction, with more or less improvement, was introduced and retained almost everywhere in both new and rebuilt theaters by Muehldorfer and Brandt, who were overwhelmed with commissions. The great success of the stage engineers of that epoch naturally induced many young men to devote themselves to this interesting profession which, however, was not easy to enter. The secrets of stage technique were then jealously guarded, for obvious reasons, and generally handed down from father to son or uncle to nephew. But Carl Brandt, who needed skilled stage mechanics for his new theaters, broke with the old tradition, and accepted not only near relations, but other young men. Thus originated at the Darmstadt court theater, a sort of school of stage engineering, whose pupils were subsequently to be found engaged in all the principal theaters of Germany and Austria.

Richard Wagner's "Rheingold," which had its first performance in 1871, at the Munich court theater, necessitated a complete rebuilding of the stage on the new plan of the Berlin Victoria theater, and Carl Brandt was intrusted with the undertaking. The scenic arrangements for "Rheingold" were to have been constructed by the former "court theater machinist," but that functionary proved unequal to the difficult task, and so Brandt had to design and create the scene of the swimming Rhine maidens, which had been denounced as impossible. He solved the problem in a masterly manner, although his solution cannot compare with those of the present. He proved the possibility of the thing, however, and stopped the mouths of the anti-Wagnerites of the day. Richard Wagner, whose attention was thus directed to Brandt, was thenceforth always associated with him. Brandt was his adviser in the construction of the Bayreuth theater, built it for him, and designed the new appliances for all his operas, including "Parsifal," during the preparations for which he died, a true and devoted friend to the Wagnerian idea. Meanwhile a few of Brandt's pupils had also attained to the dignity of stage constructors, and were enthusiastically adopting iron construction. Some of them were even bold enough to design stages of iron exclusively, and to lay their plans before theatrical architects. These gentlemen were charmed by the airy iron construction, but when they looked over the estimates and noted the total cost, which was always more than twice that of wooden structures, they became more critical, and ultimately adhered to the old and cheap wood construction. The banishment of wood from the stage and its replacement by iron was brought about, finally by a startling catastrophe: The burning of the Ring theater in Vienna, with great loss of life, in 1871, added its effect to the ever-increasing demands upon stage machinery in respect to the rapid lifting of great weights, the production of entirely novel effects, the quickest possible changes of scene, etc.

In Germany the burning of the Ring theater caused the enactment of strict laws regulating the construction of theaters, and consequently led to the erection of a great many really fireproof theaters. The increased demands upon stage machinery necessarily led to the abandonment of the antiquated and extremely primitive machinery, made almost entirely of wood, and its replacement by iron machinery of perfect design. Any one who looks back over the progress made in stage equipment in Germany and Austria during the last twenty years will be amazed by the remarkable improvement effected in that short period, and equally surprised to find the dangerous constructions of past centuries still in use, even in large theaters, in other countries whose laws are less strict—including lands so enlightened as France, Italy, England, Russia, and America. Only a few German and Austrian theatrical engineers were actively engaged in the reform which established iron construction; but these few, sparing neither their mental nor their physical energies, succeeded in adapting some very valuable new inventions to stage use. The fact that they did this without neglecting their arduous and responsible technical duties as stage directors, speaks well for their self-sacrificing devotion to the cause.

The first iron stage equipment in Austria was installed in the Bohemian national theater in Prague. The earliest built in Germany on my system were those of the court theater in Schwerin and the Berlin and Lessing theaters in Berlin. These theaters, which may be regarded as experiments or models, had simple machinery, but showed improvements in convenience of stage working and in security against fire.

Nearly at the same time came a complete revolution in lighting. Gas, the cause of many, if not most, fires, was replaced by the electric incandescent light. The history of the application of the electric light to stage illumination is very brief. During the electro-technical exhibition in Munich in 1882, the attempt was first made, in Germany, to light a stage by electricity. For this purpose a small but complete theater was erected according to my plans in the crystal palace, or exhibition building. Experiments were made with both arc and incandescent lights, and, as a result, the Residenz theater of Munich was equipped with electric illumination six months later. The court theater followed the example in two years, and now nearly every theater in Europe has electric lights. The advantages of electric light in comparison with gas are too well known to need recounting. The most important difference, and the decisive one for the theater, is that gas burns with a naked flame, but the incandescent filament is inclosed in a glass bulb, and ceases to glow when the bulb is broken. Furthermore, much stronger effects can be produced with electric than with gas light. The electric light, however, is not entirely free from danger, for fires have been caused by the overheating of conducting wires and the contact of bare wires—but such accidents are preventable. The illumination of stage and scenery is effected almost as with gas by top-lights hung among the flies, side-lights concealed behind the wings and detached pieces of scenery, and foot-lights across the proscenium. In addition to these fixed lights, special apparatus is employed for the production of special effects, moonlight, the fleeting clouds already described, etc. The well-insulated conductors, like the gas pipes, converge in the so-called regulator, the most important apparatus used in stage illumination. It includes all necessary appliances for graduating the intensity of the lights, both of the stage and the auditorium, and permits the lighting and extinguishing of temporary lamps and the sudden change from darkness to a blaze of light. As the switches for the production of color effects are also collected in the regulator, with a proper arrangement of apparatus one man can produce every needed change of light and color, thus giving to the illumination, even in difficult cases, a perfect unity and harmony with the scene, which contribute greatly to the success of the presentation. The regulator is usually placed at one side of the stage behind the wall of the proscenium, but in my arrangement it is put under the stage beside the prompter's box.

The simple iron theaters in Prague were soon followed by a great advance, exemplified in the Asphalaia theater in Pest, where the Viennese enginer Givinner introduced a stage worked by hydraulic power. The stage of the Asphalaia theater was divided into strips, parallel with the proscenium, which were supported by hydraulic presses, so that a large part of the stage could be raised or lowered, together or in sections, arranged in steps, inclined or caused to rock. The traps were also hydraulic elevators and, therefore, perfectly safe, and the drop scenes were raised by hydraulic winches. This innovation was very soon followed by the transformation of the Burg theater in Vienna, where the sub-stage is now so arranged that, in changing scenes, furniture and other solid objects are lowered with a section of the stage and then moved backward. Meanwhile the furniture and other "practicable" objects of the next scene, also resting on movable sections of flooring, are pushed forward under the stage to the proscenium, where they are raised to the level of the stage. This innovation, therefore, is confined to the quick setting and removal of furniture, and it is not without objection, owing to the great danger that persons may fall into the large openings in the darkened stage.

Another attempt to accelerate changes of scene as much as possible, though with a sacrifice of magnificence in scenic effect, was made in the construction of my reform or Shakespeare stage, which I devised at the instance of my former chief, Baron von Perfall, and introduced in the Royal theater here (Munich) and several others, in which all the front scenes remain neutral and unaltered throughout the play, and only the background changes in accordance with the action.

Although this arrangement was an improvement, it has unfortunately found few imitators, because the absence of striking scenic effect left unsatisfied the popular love of display, which has once more burst all bounds.

The electric motor, which we now find everywhere propelling drays, carriages, street cars, bicycles, and automobiles, which in the home drives sewing machines and ventilating fans—this motor, which is revolutionizing the world, tempted and allured me, until I finally captured it for the stage, to which it is as well adapted as to everything else.

The allowance of abundant funds by a far-seeing architect enabled me to equip the Deutsche theater in Munich with a completeness possessed by no other German theater then existing. Here, for the first time, I supplied all the stage machinery with electric power. The back drops, flies, drop curtains, traps and bridge elevators, the iron curtain, the property elevator, the thunder, wind, and rain machines, and the sliding scenes—all can be worked electrically. The stage, which in its normal position is one meter higher than the floor of the auditorium, can be lowered with all its iron construction, so as to form with the auditorium and the covered orchestra pit a single great ballroom. For this purpose the entire sub-stage iron structure, weighing about eighty tons, is mounted on thirteen great screws, which are turned by a 26-horsepower electric motor when the stage is to be raised or lowered.

Two years ago I provided the Mannheim court theater with a similar equipment, and applied electrical power to part of the machinery of the Prince Regent's theater in Munich and the Stadt theater in Bern. In new stage constructions quickness in scene shifting is to be regarded, for very good reason, as of paramount importance.

We have not obtained this with all our costly and excellent hydraulic and electric apparatus, because we have jealously adhered to the old stage plan.

For nearly fifteen years I advocated a rotating stage, but no one would venture to try it, not even the enterprising Herr Oskar Blumenthal, for whom I arranged the Lessing theater in Berlin. I had begun to think that I should have to give up the idea, when Herr von Possart happened to become interested in it. Soon afterward, in 1895, he commissioned me to design and construct a model of a rotary stage for the opera "Don Juan." The model met with his approbation, and I was intrusted with the construction of the stage. This was a godsend for the future of my rotary stage. The simplicity of the idea would make the rotary stage seem another Columbus egg, did not the exceedingly varied requirements of our modern spectacular pieces very greatly increase the difficulty of its practical development.

Everyone who has witnessed a performance of a Shakespearean play or of the second part of Goethe's "Faust" can form an approximate idea of the great labor involved in the production of some twenty different scenes, especially in large theaters. Every piece of scenery must be removed and replaced by another at each change of scene, and the work must be done in a few minutes if the length of the performance is not to be inordinate. Here the rotary stage aids in two ways. In the first place, from two to four complete scenes can be set up before the commencement of the play and brought successively opposite the proscenium as they are required, by rotating the stage. In the second place, while one scene is being played on the front of the stage, the change from the preceding to the succeeding scene can be made at the back, so that a change of scene, as viewed by the spectators, can be effected in fifteen or twenty seconds. For this purpose as much of the stage area as is possible, together with the corresponding part of the sub-stage, is arranged to move like a turntable, carrying with it all the sub-stage machinery, including traps, "cassettes," and shifting carriages, the whole construction resting upon rollers and turning about its center. But when the rotary stage is brought into its normal position, the entire sub-stage and all the stage machinery can be used as in any immovable stage.

The parts above the stage are like those of other theaters, except that electric power is employed; the scenery used on ordinary stages can be used on the rotary stage. But the great rapidity attained in scene shifting is not the only advantage of the rotary stage. The stage manager benefits greatly by the fact that in most plays, especially modern ones, whose scenes comprise only two or three interiors and perhaps one landscape, he can arrange his scenes leisurely during the day instead of doing so hastily at night. In most cases the outfit of furniture, etc., can be richer, as the objects do not have to be hurriedly removed, but can be left standing during the performance. As the rotary stage reduces to a minimum the length of the pauses during which the curtain is down, the time saved can be devoted to the play itself, and so it becomes possible to give many dramas unmutilated, which have hitherto had to be abridged.

In order to make full use of the advantages of the rotary stage, it must be equipped with perfect mechanism. Here electric power is to be preferred. This is now at hand, in the illuminating plant, in all large theaters, it may easily be conducted to any point, and the electric motors take up little room. The stage is turned by motors mounted on it, and connected with two of its wheels. Traps and the like can also be worked electrically. All the power switches are collected at one point at the front of the stage, so that one person can control the entire machinery. This secures a certainty of action never before attained, in addition to a great saving in labor. As all the sub-stage machinery is mounted on the rotary stage itself, it is possible to work traps and shifting carriages and raise and lower scenery during the rotation, so that the new scene is ready when the stage has come to rest.

The rotary stage, of course, is lighted by electricity. The wires for the lights mounted on movable scenery, as well as the wires for all the sub-stage motors, are brought up through the center of the rotary stage, and the current is distributed by switches. The rotary stage is also peculiarly well suited for great ballet spectacles, as it permits large and brilliantly illuminated groups and tableaux to be presented successively at intervals of a few seconds.

The greatest interest in the rotary stage has been shown abroad. The Imperial Russian theater in Moscow adopted it soon after Munich. Then followed Paris, and the Imperial Opera in Vienna, and the Burg theater in Vienna has recently made use of the rotary stage to give, for the first time, an unabridged performance of "Don Carlos."

The great attention paid abroad to the rotary stage induced me to attempt to interest in it Mr. Conried, the well-known and inventive director of the Irving Place theater in New York. The result was that I was called to New York to reconstruct the stage of the Metropolitan Opera House, and to mount the principal works of Richard Wagner. I naturally took advantage of this interesting visit to make a thorough study of local theatrical conditions. The first American theater that I visited was the New York theater, where a great spectacular drama, "Ben Hur," was being performed.

The peculiar auditorium, the parquet of which is only a few steps above the street, differs very greatly from our ordinary theaters, but strongly resembles the ancient and the Bayreuth and Prince Regent's theaters. As with the American in general, the practical plays a far more important rôle than the æsthetic, the upper space has been utilized by constructing three galleries or amphitheaters, one above another, so that the second projects over the parquet to half the depth of the auditorium, and the third is but a few yards less in depth. The wedge-shaped proscenium also contains six boxes on each tier. The unfortunates who occupy the cheap seats under the gallery are not to be envied. The performance of "Ben Hur" differed in no respect from the spectacular pieces given in the unsubsidized theaters of London and Paris. There were beautiful costumes, splendid pageants, rather poorly-lighted scenery, and mediocre performers with a few male and female stars. The chief source of attraction for the public was a mechanical trick that had been done in London years before, the chariot race in the arena. Each two-horse chariot ran on a track divided into two sections, made of narrow beams hinged together to form an endless band, which moved on numerous friction rollers and over a cylinder at each end, and was driven by an electric motor and the galloping horses. As the track moved in a direction opposite to that of the horses, the latter, though in full gallop, remained with their chariots nearly on the same spot. A panorama in three sections, which moved rapidly in the opposite direction to the horses, was intended to complete the illusion. The purely mechanical problem was solved admirably, and produced what is wanted in America, a sensation, but no æsthetic pleasure. The mechanism of the trick was so obvious that illusion was impossible. I also visited the new and splendid Majestic theater in Columbus Circle, where "Babes in Toyland," a sort of fairy spectacle with music and startling effects, was given throughout the season.

Next I went to the Casino, ornamented in Oriental style, which offered the novelty of ballet girls in phosphorescent costumes, very interesting from a technical point of view, but not sufficiently striking for the public. At the Broadway theater I saw Henry Irving's "Dante" appropriately mounted, with admirable lighting effects. At the Belasco, one of the most celebrated theaters, a Japanese drama ("Darling of the Gods") was given with as splendid a setting as can be found in any theater in Europe. The new American theater, an immense structure, offered nothing striking, and the Garden theater in the Madison Square Garden, where "Odysseus" was being performed, also failed to please me. The Knickerbocker theater, celebrated for its fairy spectacles, was giving "Bluebeard" in mediocre style. I found something unique and very interesting in the old and small Madison Square theater. The stage is constructed like a warehouse elevator which has the breadth of the proscenium, the depth of the entire stage, and the height of two superimposed scenes. The lower story is intended chiefly for interiors, the upper for either interior or outdoor scenes. The double stage is suspended and balanced by counterweights. When it is raised, the upper scene vanishes and gives place to the indoor scene, which has been set below, the ceiling of which forms the floor of the preceding scene. A new scene can now be set above and lowered at the proper time, to replace the interior scene, and so on. This stage is by no means fireproof, and the fire in Chicago (in the Iroquois theater) has led the authorities to close the theater for reconstruction. This precaution is easy to understand, but I can not understand why the New York fire department is satisfied with its antediluvian system of protection against fire in theaters. In New York it is deemed sufficient to supply theaters, like warehouses, with automatic sprinkling apparatus, which is certainly very useful in the dressing, property, and other rooms with comparatively low ceilings. But on the stage such automatic sprinklers fastened under the machine loft at a height of eighty or ninety feet are entirely worthless, for when the flames have got as high as this, neither the sprinklers nor anything else is of any use.

A fire occurring on the stage must be kept within small compass, and therefore the theater should be watched, night and day, by firemen who are thoroughly acquainted with the building, not, as in New York, by a single fireman, who appears on the stage for a short time once during the performance. There should also be a Stele extinguishing apparatus, by which the whole stage can be flooded with water at any moment, and an iron curtain in the charge of responsible persons—not the ridiculous asbestos one still used in all New York theaters. But with criminal carelessness the Americans refuse to understand these things or to learn from experience, and further catastrophes are likely to occur. The Yiddish and Chinese theaters in the Bowery are very interesting, although their appointments are not models for imitation. The largest and most important theater in New York, the Metropolitan Opera House, has an auditorium which resembles those of our Court and National theaters in Munich, though it is very much larger. The stage has approximately the dimensions of that of the Prince Regent's theater, but lacks the valuable back stage of the latter. The stage equipment was—as it still is in nearly all American theaters—that of a hundred years ago. No machine hoists, in the upper machinery only hand ropes, in the under stage, which was 30 feet deep, no traps or elevators, nothing but a solid stage, at the back of which the floor could be built up to different heights with the aid of movable trestles.

Mr. Conried saw the impossibility of giving proper Wagner performances with this primitive equipment. At my suggestion he appropriated a large sum of money, and in six months the stage was provided with every new mechanical device, the antiquated electric-lighting system was reconstructed, and the Metropolitan Opera House (the principal theater in America) had a German stage system, which made it possible to mount Richard Wagner's works worthily and successfully.

Therewith a forward step was made, which is destined to bring the art of the stage engineer to high honor, even in the land of the dollar.

THEORIES OF WORLD-BUILDING.*

By A. P. COLEMAN, Ph.D., Professor of Geology, University of Toronto.

THE nebular hypothesis of Kant, La Place, and others has long been accepted as satisfactorily explaining the origin of the solar system and of our world, starting with a "fire mist," intensely hot, in rotation, and acted on by gravitation. Contraction by loss of heat is supposed to have caused annulation, and the rings to have collected into planets and satellites. The hypothesis is beautiful and comprehensive, and accounts very well for many relationships between the sun and planets—such as the plane of their orbits, and also of most of the moons. From the geological side, it explains the earth's internal heat and its oblate spheroidal form.

There are, however, numerous and serious objections to the hypothesis, both astronomical and geological. There should be, among the nebulæ, examples of systems in all stages of formation, including annulation on a general scale, but the stages are infrequent and of a doubtful significance. Among the 5,000 nebulæ, few instances of the annular form are known, and, I believe, still fewer of a great nucleus with rings about it. Saturn's rings are known to consist of discrete particles.

The original heat of the nebula must have been intense to keep all the substances of the Solar System volatile, and this implies exceedingly high molecular velocities—i. e., the average velocity in feet per second, with the barometer at 760 millimeters, is as follows for certain gases:

	0° C.	1,000° C.	4,000° C.
H_2	5,653	12,240	22,363
H_2O	1,883	4,064	7,453
O_2	1,306	2,823	5,163

Individual velocities may be much higher. Under these conditions, even when cold, the smallest planets and satellites have not attractive power enough to retain an atmosphere, owing to the high molecular velocities. Any body has power to control molecules shot away from it only at velocities below a certain limit. Up to this point the paths are elliptic, but beyond it parabolic. On the earth's surface the parabolic velocity is 6.9 miles per second, and it diminishes with the height and consequent increase of centrifugal force. The velocities increase, of course, with the temperature.

The temperature of the supposed nebula when it became liquid was probably over 4,000 deg. C., which was high enough to dissociate water. Hydrogen has so high a parabolic velocity that the present cold earth hardly retains any of it. At nebular temperatures the earth would be incompetent to retain any of its gases or of its water.

The momenta of the solar system do not correspond to the nebular hypothesis. With the rate of motion of Neptune the momentum of the nebula would be 213 times the total momenta of the solar system; and similar calculation for a nebula extending to other planets gives quite discordant results. What has become of the lost momentum?

The geologist objects to the nebular hypothesis because it cuts down the amount of time since water could work upon the earth, giving far too short a space for the phenomena recorded in the rocks. For these and other reasons geologists require a more satisfactory theory, and hope that the new one presented by Prof. Chamberlin as the planetesimal hypothesis will correspond better to the facts. This is, in a sense, a modification of Lockyer's mèteoritic hypothesis, and supposes that small particles fell together at small velocities, not causing a high surface temperature. Each particle carried its small quantum of gases, as meteorites do, and these gases were entrapped in the porous mass. Until the size of the moon was reached, no atmosphere could be retained.

Gravitation gave self-condensation, and thus generated heat in the interior, aided by tidal kneading and chemical action. So that, at lunar size, there was (1) a dense, central, hot sphere; (2) a zone of declining temperature; (3) an unconsolidated, porous, cold surface. The central heat tended to drive out the gases, and gravitational pressure aided in this. The gases condensed in the outer porous layer in the intense cold of space, as, possibly, they do now in the moon. The gases may have been expelled in explosive volcanic activity, producing, perhaps, the lunar craters.

* From the Proceedings of the Royal Astronomical Society of Canada.

As the planet grew it would hold gases better and better, and become inclosed in an atmosphere retaining solar heat, until the surface temperature permitted water to exist as a liquid, when rivers and ocean would begin their work. On this theory the atmosphere is derived from the interior of the earth, but part of it may have been collected from wandering gases. The present atmosphere may reach outward 620,000 miles, but beyond that it would be drawn to the sun. That the original particles might be the source of our atmosphere is proved by the presence of gases in meteorites.

The heat produced by the falling together of matter of specific gravity ranging from 3.5 to 5.6 (the average of the earth) is sufficient to raise the whole mass of the earth to 6,500 deg. C., which is four times the average melting-point of ordinary rocks.

The shrinkage of the earth by self-condensation would be far greater than by loss of heat, the latter providing only 600 miles of shrinkage in circumference, and that mainly in early times. This amount is far too little to account for all the mountain ranges. Hence the inequalities of the surface, such as sea bottoms; continents and mountains are better accounted for by the planetesimal hypothesis. The length of geological time also is greatly increased, which accords better with geological requirements.

There are many other points in which this theory harmonizes best with the results of geological investigation, such as the fact that the earth has always been cold on the surface since our record begins, and by the planetesimal hypothesis the internal heat may be still increasing instead of diminishing. Volcanic activity, with its immense outpourings of steam and gases suggests that the atmosphere and ocean are still growing, which would be impossible under the nebular hypothesis.

The old theory made all the carbon of the earth come from the atmosphere, which must in early times have contained at least 20,000 times as much carbonic acid as now. Animal life would be inconceivable under those conditions.

The earliest known rocks are sedimentary and not igneous, as the old theory demanded. Volcanic phenomena are easily explained if water and gases already exist in the rocks, and the fluid and gaseous inclusions in igneous rocks are accounted for. It is possible also to explain volcanic activity at a distance from the sea coast. The amount of water given off as steam by one parasitic cone on Mount Etna has been estimated at 462,000,000 gallons in 100 days, and the whole volcano may have given off 1,000 times as much in the time, and this is explainable if the volcano is an outlet for the earth's original gases, which could never have remained there in a molten earth. The hypothesis simplifies the explanation of geological climates by furnishing a continuous source of carbonic acid to the atmosphere.

The brief comparison of the Nebular and Planetesimal Hypothesis given above is taken mainly from the writings of Prof. Chamberlin, of Chicago, and Prof. Fairchild, of Rochester, and supplies the reasons why geologists prefer the more recent theory.

RUBBER.

THE following extract is taken from Mr. Eugène André's "A Naturalist in the Guianas," a most interesting work lately published by Messrs. Smith, Elder, & Co.

Of rubber, two kinds are shipped—true rubber, the product of trees of the genus Hevea, and balata rubber, obtained from the order Sapotaceæ—the principal source of supply being *Mimusops balata*. The true rubber—or, rather, India rubber—is similar to the article exported in such large quantities from Pará, in Brazil, and, like the Brazilian product, it comes from considerable distances in the interior. Whereas India rubber has been known to science for quite a length of time,* and has been put to commercial uses for more than half a century, it is only within the last decade that an extensive trade in balata gum has sprung up, although, so far back as 1857, Prof. Bleekrod called attention to its value as a substitute for guttapercha.†

The tree producing this gum is one of the largest of forest trees. Its timber is exceedingly hard, heavy, and durable, and is of a fine claret color. It is found all over the West India Islands, and in Venezuela, being particularly abundant in the Guianas, where the preparation of balata gum has become within the last four or five years a very important industry. Unfortunately, the method employed to obtain the gum is sure to lead to the destruction of this industry, which, if conducted on intelligent principles, might constitute a permanent source of wealth to the countries where the balata tree is found in the forests. It is almost impossible to exercise any control over the gum collectors in the vast expanses of forest where their operations are carried on, so that they are at liberty to work in whatever manner they choose, and they have in consequence adopted the method which gives the least labor and the biggest return. Instead of judiciously tapping the trees, the gum collectors throw them down, and then, by scoring the bark of the trunk and branches, they secure all the sap they can, which they then boil and cast into rough molds.

Sometimes the gum is brought to market in the shape of large blocks. The experienced trader, who has learned that these blocks may contain heavy stones or other materials not valuable as gum, is very careful

* Torquemada, in his "De la Monarquia Indiana," published at Madrid in 1615, says: "There is a tree which the Indians call Ulequahuitl. It is held in great estimation and grows in the hot country. It is not a very high tree; the leaves are round and of an ashy color. This tree yields a white milky substance, thick and gummy, and in great abundance."

† Journal of the Society of Arts, October 9, 1857.

in dealing with this class of merchandise. Like most hardwood trees, the balata is of very slow growth. Those giants of the forest, recklessly destroyed in a few short hours, have taken hundreds of years to attain their full development. In ten or fifteen years there will not be, it is to be feared, a single balata tree in the districts where gum is being obtained by the destructive system in vogue among the collectors. What is most to be regretted in the wholesale destruction of these trees is that the very valuable timber they might supply is allowed to remain and rot on the ground. Of course, the reason for this is that in most cases the trees are found in the depths of the forest, far from any road, so that the dragging out of logs of this heavy wood would be an undertaking too costly to leave any return on the outlay.

LORD BLYTHSWOOD'S LIQUID AIR PLANT FOR EXPERIMENTAL WORK AT LOW TEMPERATURES.

By the English Correspondent of SCIENTIFIC AMERICAN.

THE great advances made in the attainment of low temperatures within the last ten years have been the result of long and patient work on the part of many investigators. Ten years ago liquid air could only be obtained at a few cryogenic laboratories. Hydrogen had not then been obtained as a static liquid. Now the subject may be said to be entering on the second stage of its history, when apparatus for the production of liquefied gases has become an essential feature in the equipment of a chemical or physical laboratory. It is now possible to obtain well-designed apparatus for the production of liquid air or of liquid hydrogen in quantity.

An interesting plant of this type has recently been installed in Lord Blythswood's private laboratory, at Renfrew, near Glasgow, and some valuable researches and experiments are now being conducted thereat. A description of this work at low temperatures as carried out at this laboratory, together with the installation, was recently given by Mr. H. Stanley Allen before the Royal Philosophical Society of Glasgow.

The plant for low-temperature research at the Blythswood laboratory comprises apparatus for the production of liquid air and also liquid hydrogen. The installation for liquid air, which was completed in March, 1904, consists of a Whitehead torpedo compressor working in conjunction with a Hampson liquefier. The air of the laboratory, freed from carbonic acid by passing over trays of slaked lime in the "low-pressure purifier," is compressed in two stages to nearly 200 atmospheres (3,000 pounds per square inch). The cylinders of the pump are kept cool by water circulating through surrounding tanks. From the compressor the air passes to a strong cylinder, in which the bulk of the water is deposited, then through a second cylinder containing solid caustic potash. The pure dry air enters the Hampson liquefier, and after passing through four coaxial spiral coils of copper, is allowed to expand at a throttle valve. The air cooled by expansion passes back over the coils, and so cools the incoming air. In this way a continually increasing effect is produced, and the temperature is reduced to such an extent that liquefaction at length occurs. This generally takes place in seventeen or eighteen minutes after starting the compressor. The liquefied air is collected in a chamber containing 127 cubic centimeters, from which it is drawn at intervals of five minutes. The present apparatus is capable of producing a liter and a half (nearly three pints) in an hour. The compressor requires six horse-power to drive it, and one man requires to be in constant attendance.

An internal view of the liquefier is shown herewith. The high-pressure purifier is seen in the illustration attached to the pillar of the stand, on the left-hand side; the low-pressure purifier stands by itself to the left.

The apparatus is capable of working continuously with a compressor able to deliver air at a pressure of 100 atmospheres or over. It begins to liquefy air in from six to ten minutes after its admission, when the compressor is working at from 150 to 200 atmospheres pressure. The appliance requires no ice or salt, carbonic acid, or other auxiliary refrigerant. A perfectly clear liquid is produced, and no filtering is required.

The principle of the action of the air liquefier is more comprehensively shown in the accompanying diagrams.

The compressed air, when moisture and carbonic acid have been drawn off, passes into the regenerator coils, *B*, through the connection, *A*. It travels down the coils, and escapes through the valve, *C*, which is regulated by a hollow spindle, *D*, to which a hand wheel, *E*, is attached on the top of the apparatus. The air released through the valve, *C*, immediately expands down to atmospheric pressure or thereabout, and travels back over the regenerator coils, *B*, finally escaping either into the atmosphere direct through the passage, *F*, or back into the compressor to be recompressed.

The expanding air acts with a self-intensive cooling effect on the compressed air, which is passing down through the coil in the manner already described, and the efficiency of the apparatus is such that in from six to ten minutes part of the air begins to liquefy and collect in the receiver, *G*. The small glass gage, *H*, containing colored water is employed to indicate the amount of liquid air in the receiver, *G*. It communicates with the receiver by means of the pipe, *J*, and the hollow spindle, *D*, of the expansion valve, *C*. When liquid air collects in the receiver, *G*, it compresses the air in the pipe, *J*, and so displaces the colored water in the glass gage, *H*, causing it to rise in the vertical glass indicating tube, which is attached to it.

The glass gage, *L*, indicates the pressure at which the returning air passes away from the liquefier. This pressure is about 12 inches of water, and is due to the friction in the tubes leading from the liquefier to the compressor.

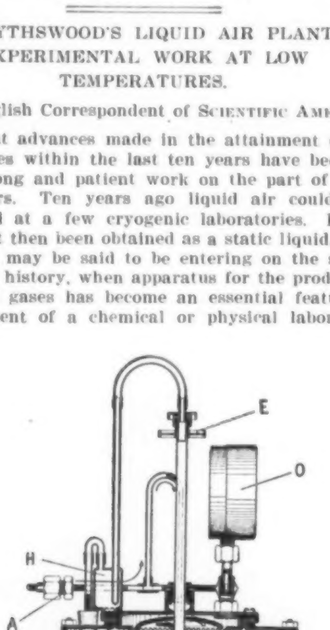
The temperature of the air leaving the liquefier is indicated by means of the thermometer, *K*, while there is also a socket, K_1, in which a thermometer can be placed to register the temperature of the compressed air as it enters the regenerator coils. The pressure of the compressed air as it enters the regenerator coils is registered on the pressure gage, *O*. When it is desired to withdraw liquid air from the receiver, *G*, the valve, *P*, at the bottom of the receiver is opened by turning the hand wheel, *T*. The liquid then enters the hollow spindle, *R*, down which it flows into a portable vacuum vessel, in which it is collected.

The liquid hydrogen plant was set up under the direction of Dr. Morris Travers. It consists of apparatus for the production and purification of hydrogen gas, and a liquefier constructed by Brin's Oxygen Company, of London, to Dr. Travers's designs. The hydrogen is generated in a lead vessel by the action of dilute sulphuric acid on pure zinc. The gas is purified by passing it through four stoneware jars containing pumice stone moistened with the necessary reagents. The first jar contains potassium permanganate, the second and third silver sulphate suspended in water, and the fourth caustic potash. The gas is stored over water in a gasometer holding 100 cubic feet (3 cubic meters).

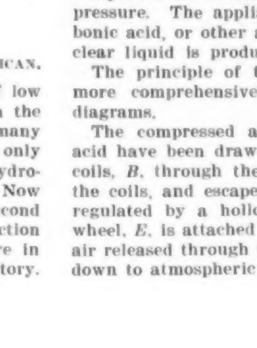
The production of liquid hydrogen presents more difficulties than the production of liquid air. The nearer the absolute zero of temperature is approached, the more difficult does further progress become. The experiments of Joule and Thomson showed that in the case of hydrogen the gas, when allowed to expand freely at ordinary temperatures, was heated instead of cooled. It is only when the initial temperature is below 79 deg. C. that the converse effect is produced. It therefore becomes necessary to cool the gas below this temperature before it enters the regenerator coils of the liquefaction apparatus. After the compressed gas has been dried it enters the liquefier, in which it passes through a single coil of copper pipe. One portion of the coil is cooled by liquid air, and in the succeeding portion the temperature of the gas is still further reduced by liquid air evaporating under diminished pressure.

The regenerator coil, which is cooled by the current of hydrogen after the expansion at the valve, is contained in a chamber 80 millimeters in diameter and 190 millimeters long. In this apparatus there is a second regenerator coil, over which the cold hydrogen passes, with the result that the gas leaving apparatus is only a few degrees colder than the gas which enters it.

The accompanying sectional elevation shows the general construction of the hydrogen liquefier. The hydrogen, after compression to a pressure of from 150 to 200 atmospheres and purification, enters the lower end of the coils in the chamber, *A*, where it is cooled by the cold hydrogen returning to the supply gas holder. It then passes into the top of the coils in the chamber *B*. This chamber is filled with air, so by the time the compressed hydrogen has reached the lower ends of the coils in the chamber, *B*, it is cooled down to the temperature of liquid air, viz., 190 deg. C. The cold compressed air then passes into the coils contained in the chamber, *C*, into which the liquid air is allowed to drop through a small valve regulated by a spindle extending to the top of the apparatus. A partial vacuum is maintained in the chamber, *C*, by means of a small exhaust pump connected to the pipe, *D*, so that the liquid air passing into the chamber is evaporated *in vacuo*, thus reducing the temperature below 200 deg. C. The compressed hydrogen, still further re-



Full length sectional View of Air Liquefier.



Part sectional View of Top of Air Liquefier.

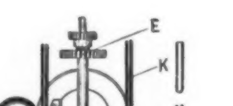
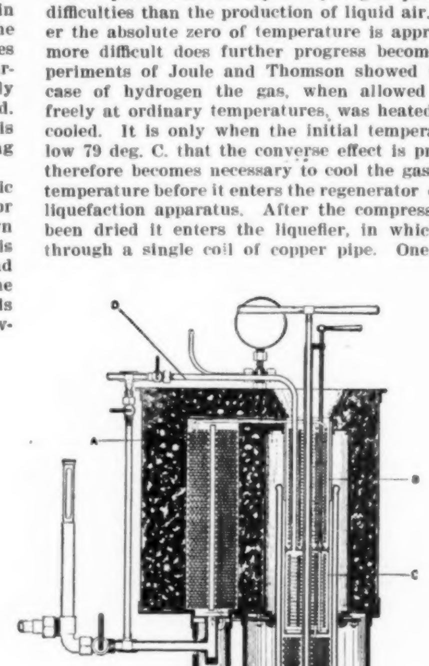


Diagram showing arrangement of Regenerator Coils.



Cross-section of the Hydrogen Liquefier.

CROSS-SECTIONS OF APPARATUS FOR LIQUEFYING AIR AND HYDROGEN GAS.

duced in temperature, then enters the regenerator coil, *E*. This coil is contained in a silver glass vacuum vessel with an opening at the lower end of it. The bottom of the regenerator coil is attached to a valve regulated by a spindle extending to the top of the apparatus, and through this valve the compressed hydrogen finally escapes and expands to normal atmospheric pressure, or more strictly speaking to the slight pressure of the gas-holder to which the bulk of the hydrogen returns. On its way back to the holder, however, it is caused to pass over the regenerator coil, *E*, with self-intensive cooling effect. It then passes round the outside of the chambers, *C* and *B*, into the chamber, *A*, where it acts with further cooling effect on the incoming hydrogen in the manner already explained. Thus the hydrogen returning to the holder is only a few degrees colder than when it entered the coils. The remaining hydrogen has been liquefied at the point of expansion, and collects in the vacuum vessel, *K*.

The efficiency of the liquefier is such that liquid hydrogen begins to collect in the vessel, *K*, in a few minutes after the apparatus is started. As liquid hydrogen cannot be drawn off through a stopcock without great loss, the liquid is collected in the receiver, *K*, immediately it is formed in the bottom of the vacuum vessel surrounding the regenerator coil, *E*. The receiver, *K*, is contained in a separate metal box below the apparatus. This box has glass windows at the front and back, so that the process of liquefaction can be watched. It is held in place by hinged clamping bolts, which compress a rubber ring between the two flanges, so as to form a gas-tight joint, and it is so arranged that when these bolts are released, it can be lowered on a slide, *L*, and turned independently, so that the receiver, *K*, can be readily changed and the box returned to its original position without stopping or in any way disarranging the apparatus. The liquefier is capable of producing about 2 liters of liquid hydrogen per hour, and about 5 liters of liquid air are required in the production of 1 liter of liquid hydrogen. As all unliquefied hydrogen is returned to the gas-holder, very little is lost.

The Whitehead torpedo gas compressor is capable of compressing about 550 cubic feet of gas per hour to a pressure of 200 atmospheres when running at a speed of 400 revolutions per minute. Under these conditions it requires from 6 to 7 I. H. P. to drive it, and it will produce through the Hampson liquefier 1½ liters of liquid air per hour. The compressor occupies a ground space of 4 feet 8 inches by 2 feet 3 inches, and stands from its base about 2 feet high.

The plant at the Blythswood laboratory was first used on January 14 last under the superintendence of the designer, Dr. Morris, and liquid hydrogen was made on that date for the first time in Scotland. About 400 cubic centimeters of the liquid was collected in a Dewar flask provided with a double vacuum jacket.

AN ELECTRICAL LONG-DISTANCE WATER-LEVEL INDICATOR.*

By our BERLIN CORRESPONDENT.

IN connection with the improvements of the Wien River, Mr. Hans Baumeister, of Vienna, Austria, has designed an interesting apparatus for recording the water level of a river, at a distance. After three limnigraphs recording the water level at three different points had been installed, it was found necessary that the office of the High Water Service should be kept posted as to the water level of the river below the mouth of the Mauerbach, at all times and especially at night. Telephonic information proved impracticable, necessitating as it did the continual presence of a superintendent in the limnigraph cabin. Electric transmission as used in the present apparatus was therefore resorted to.

The apparatus consists of two independent parts, the transmitter, installed in the limnigraph cabin, and the receiver, placed in the administration building of the High Water Service.

The Transmitter.—In a concrete pit communicating with the bed of the river by means of a horizontal iron pipe 7.9 inches in diameter, is located a float. This float is connected by a wire with the apparatus, which is placed on a concrete base at the upper edge of the pit. The wire from the float actuates the large wheel shown in Fig. 3 at *S*. On the same shaft are mounted two other wheels, the tightening wheel, S_1, from which is suspended a counterweight to give the wire the necessary tension, and the small pinion, *z*, engaging with the rack that moves vertically. The vertical reciprocating movements of the float are duplicated by the rack in the reduced ratio of 1 to 12.5. The upper end of the rack moving between guides bears the horizontal arm, *A*, which carries a contact peg.

The above parts and their arrangement on a cast-iron support are wholly analogous to those of the Schäffer self-recording water-level indicator or limnigraph. By using this ready-made device, a considerable saving in cost is effected.

The horizontal brass arm at the upper end of the rack, which carries the contact peg, slides up and down on the circumference of a contact roller, *K*, which rotates around a vertical axis. The roller is divided on its circumference into 29 horizontal disks, each disk corresponding to a given water level, and being characterized by a telegraphic signal of dots and dashes, which project in relief from the circumference. A given signal is repeated about ten times at regular intervals upon the circumference of the contact roller or drum. Now, by the rotation of the drum, which is operated by clockwork, the contact peg, *S*, rigidly fastened to the arm, will come into temporary contact with the above-mentioned signal projections. As the roller and the contact arm are included in an electric circuit, the latter will be closed whenever the platinum peg, *S*, strikes a projecting signal mark. When this occurs, the receiver installed in the administration building is actuated. As shown by Fig. 5 all the projecting points corresponding to the signals are narrower at

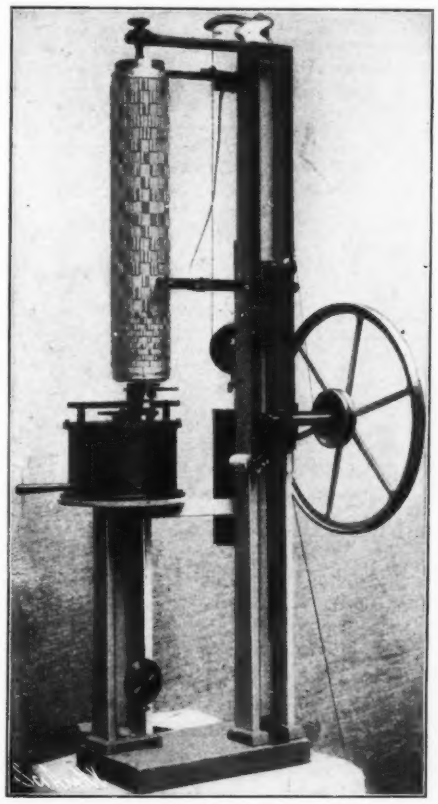


FIG. 1.—THE TIDE-RECORDING TRANSMITTER.

the top than at the surface of the drum, in order to diminish the resistance in rotating. Water levels from 0 to 1 meter or 39.4 inches are recorded by the roller in steps of 10 centimeters, or 4 inches each, whereas those between the levels of 1 and 4.6 meters are indicated at 8-inch intervals.

The curve of water levels as registered by the platinum peg on the roller is thus separated into steps of 10 or 20 centimeters each, and the signals corresponding to the different levels are electrically transmitted to the receiver and recorded. The zero of the apparatus, which is located 14½ inches above the lowest point of the bottom of the Wien River at that place, is recorded by a continuous contact at the lowermost disk on the drum. In determining the portion of the circumference taken up by each of the ten signals for every level, care has been taken that in case of a rapid rise or fall of the river, the contact peg shall never cross a disk without recording at least one complete signal of the ten thereon. The roller makes one revolution per hour, or a point on the circumference moves 9.85 inches in that time. On the assumption that the most rapid change of level of the water is at the rate of 39.4 inches per hour, the inclined line traced by the contact point would have a grade of 1:2.8, or means of screws. The complete roller was then nickel-plated throughout.

The contact arm (see Figs. 4 and 5) consists of two flat brass bars, l_1 and l_2, in contact at the right-hand end, where they are rigidly connected to the upper end of the rack, z_1. The bar, l_1, which is free to rotate about a vertical axis at the junction with l_2, bears a spring, *f*, at its left-hand end, which carries the platinum contact peg. The distance between this spring and the bar, l_1, is regulated by the screw, s_4.

The distance between the peg and the surface of the contact drum is regulated by an adjusting screw, s_2, while its level with respect to the water level is adjusted by means of the micrometer screw, s_3, the nut of which is rigidly joined to the rack, z_1.

As regards the electrical connections, one terminal of the local battery is connected to the contact arm by a suspension wire, and the other terminal by a brush to the shaft of the drum, the pressure of the sliding contact being regulated by an adjusting screw. The clockwork driving the drum is of very substantial construction, and it is necessary to wind it only once every seven days.

The Receiver.—When the circuit is closed in the transmitter, an electro-magnet is electrified in the receiver. This attracts an armature, which is solidly connected to a vertical arm, a_1, Fig. 6, and which turns around a horizontal axis. The vertical arm, a_1, communicates through a screw bolt with the recording arm, a_2, proper. In a socket at the upper end of the latter arm is fitted the recording fountain pen. When the circuit is interrupted, the armature is instantaneously lifted from the electro-magnet by a spiral spring. In the immediate neighborhood of the point of the recording pen is placed the recording drum, 9½ inches in diameter, rotating around a horizontal axis and bearing on its circumference a special form of recording paper.

As the contact peg of the transmitting apparatus slides over a projecting mark, the circuit is closed, the armature at the receiving station is attracted by the magnet, and the pen is pressed against the rotating drum. The length of the ink mark thus produced on the paper depends on the breadth of the signal projection, and on the ratio of the speed of rotation of the contact roller to that of the recording drum. The ratio of the peripheral speeds of the two rollers is 2 to 3, so that the duration of the contact in the receiver will be one and a half times that in the transmitter. By consulting the table shown in Fig. 9, the water levels may be ascertained from these telegraphic dot and dash signals thus produced on the recording drum.

Means are provided for adjusting the recording pen, so as to insure clear records on the paper. The distance between the pen point and the drum is determined by the two adjusting screws, *s*, and the elastic pressure of the pen against the drum is secured by a spring bearing on the arm, a_2, which carries the pen and rotates independently around the bolts, *b*. The recording drum completes a revolution every two hours. As its axle has been threaded and runs through a stationary bearing, a rotation is attended by a lateral displacement of 0.4 of an inch to the right. The marks made by the pen will consequently lie on a helicoidal line whose pitch is 0.4 of an inch. As the drum is 5½ inches in length, the record can be kept for 28 hours without changing the paper. The same paper may, however, be used for four or five days consecutively in case of zero water level; but in case of both high and medium levels, the paper should be changed every 24 hours.

The drum is driven by the clockwork, *K* (see Fig. 8), the toothed wheel, z_1, engaging with the driving gear, z_2, 5½ inches in breadth, which actuates the pinion, z_3. The last is attached to the shaft of the drum. This shaft has been threaded with a square screw thread of

FIG. 2.—THE RECEIVER FOR RECORDING THE RISE AND FALL OF THE TIDE.

an angle of inclination of 19 deg. 23 min. Now, for each signal disk the difference between the marks has been chosen such that the above-mentioned line of greatest inclination would pass over two signals, as shown in Fig. 3*a*.

The contact drum was made by dividing a drawn brass cylinder into 29 horizontal disks, each of which had notches cut into the surface, which corresponded to the spaces between the signal dots or dashes. The individual disks were fitted on the circumference of a cylinder in their proper order, and fastened thereto by

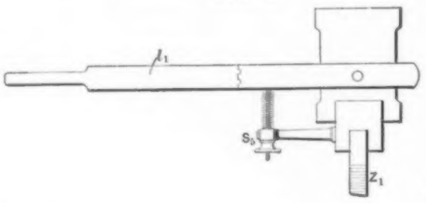
0.4-inch pitch, from the left-hand edge of the drum to the pinion, z_3. In the open bearing, *l*, has been placed a screw-thread cam engaging with the thread on the shaft, so that with the rotation of the latter, the shaft, recording drum, and driving wheel, z_2, are displaced to the right. The total displacement being 5½ inches, the driving wheel, z_2, has been given a breadth of 5½ inches, to insure the permanent engagement of z_2 and z_3.

The paper placed on the recording drum is divided into 13 parallel longitudinal strips, whose obliquity

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

corresponds to that of the helicoidal line described by the recording pen. The breadth of these longitudinal strips is equal to the pitch of the thread of the drum axle, and corresponds to a period of two hours. By dividing the paper into 24 equal parts parallel to the

FIG. 4.



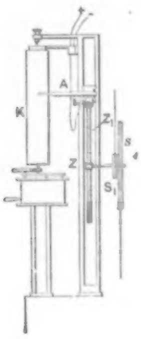


FIG. 3.

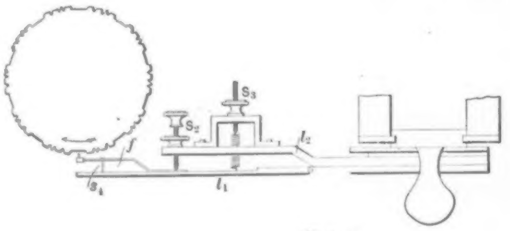


FIG. 5.

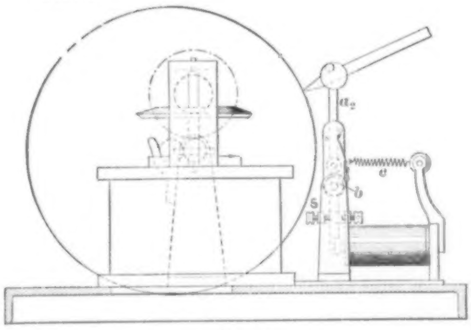


FIG. 6.

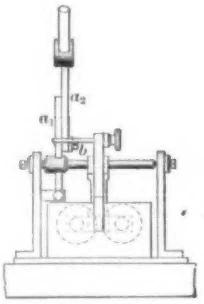


FIG. 7.

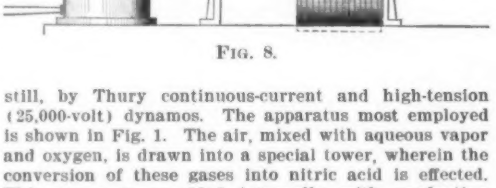


FIG. 8.

axle of the drum, a subdivision into periods of five minutes each is obtained.

Six battery cells located in the administration building serve as the source of current. The circuit is a metallic one, so as to eliminate any temporary disturbances due to a ground return. Both the transmitter and receiver are placed in protective glass boxes.

In Fig. 9 is shown a sample of high-water records taken on March 2, 1904.

The apparatus, which has been working satisfactorily for about two years, was constructed by Messrs. Czeija, Nissl & Co., Vienna.

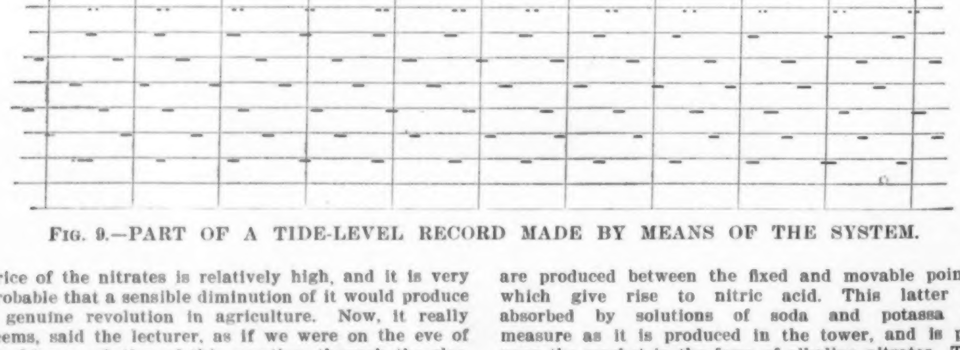


FIG. 9.—PART OF A TIDE-LEVEL RECORD MADE BY MEANS OF THE SYSTEM.

AGRICULTURAL ELECTRO-CHEMISTRY.*

BEYOND a doubt, for that interesting branch of modern science called electro-chemistry there is a brilliant future in store. A fact of which, perhaps, many people are ignorant, is that there is also a branch called agricultural electro-chemistry. This latter formed the subject of a lecture that M. Guarini recently delivered at the Belgian State Agricultural University, and in which he enumerated the different applications of electro-chemistry to agriculture, and especially to the industries connected therewith. He divided the agricultural electro-chemical applications into three classes, viz.: (1) Those that relate to the manufacture of products necessary to agriculture, say in the form of chemical fertilizers; (2) those of ageing; and (3) those of purifications.

A. Manufacture.—M. Guarini first summed up the present state of the electric manufacture of the nitrates that play an essential part in agriculture, since it is these, in the form of artificial fertilizers, that permit of furnishing the plant with the assimilable nitrogen that is indispensable for its development. The market price of the nitrates is relatively high, and it is very probable that a sensible diminution of it would produce a genuine revolution in agriculture. Now, it really seems, said the lecturer, as if we were on the eve of reaching a solution of this question, through the electric manufacture of nitrous products.

It has been known for a long time that the electric spark, when traversing the air, unites the nitrogen and oxygen of this gas and gives rise to nitrous products. It is the characteristic odor of nitrous vapors, combined with that of ozone, that we perceive immediately after a flash of lightning during a thunder storm, and that ordinary folk improperly designate as the "odor of sulphur." Thanks to the labors of Berthollet and Hofman, we know that the electric spark, as well as the silent discharge, brings about a combination of the oxygen and nitrogen of the air, and, when the action takes place in the presence of aqueous vapor, gives rise to nitrous acid.

Instead of tensional electric sparks, we more profitably employ those of quantity, since they produce a high temperature which is advantageous from the viewpoint of the yield, in nitric acid. The high tension current may be produced by an alternator with or without a transformer, static machines, or, better still, by Thury continuous-current and high-tension (25,000-volt) dynamos. The apparatus most employed is shown in Fig. 1. The air, mixed with aqueous vapor and oxygen, is drawn into a special tower, wherein the conversion of these gases into nitric acid is effected. This tower is provided internally with conducting points. An insulated metallic cylinder, concentric with the tower, is likewise provided with points, and is capable of slowly revolving. It is connected with the positive pole of the source, and the tower with the negative pole. A large number of instantaneous arcs are produced between the fixed and movable points, which give rise to nitric acid. This latter is absorbed by solutions of soda and potassa in measure as it is produced in the tower, and is put upon the market in the form of alkaline nitrates. The production varies with the apparatus and the kind of current employed. It ranges from 40 to 100 grammes of nitric acid per kilowatt-hour, with the cost of which the price also varies. The following are a few estimates of th net cost of nitric acid manufactured electrically:

The kilowatt-hour produced by hydraulic generators costs on an average 0.0095 of a franc ($0.0019), and by the De Kowalski and Mosckiki process, in which is utilized a mixture of air and oxygen obtained through the liquefaction of air, it would be possible to produce 100 kilogrammes (220.46 pounds) of nitric acid at 9.50 francs ($1.90). At Niagara Falls, where 375,000 horsepower will soon be had, the cost per kilogramme would be half of this figure. Now, at 4.75 ($0.95) or even at 6 francs ($1.20) per 190 kilogrammes of nitric acid, the manufacture would afford a very large profit, sufficient to assure the payment of a considerable part of the general expenses and the interest on the capital invested. The present selling price of nitric acid of 36 deg. B. is from 26 to 27 francs ($5.20 to $5.40) per 100 kilogrammes. It should be added that the nitrous products are delivered to agriculture in the form of nitrates of potassa and soda. In certain cases, in which the latter might not be necessary as fertilizers, it might be advantageous to employ nitrate of lime, which can be produced more cheaply.

B. Ageing.—The result of an appropriate electric treatment is to permit of ageing alcohol and wine in a short time. Old wine, as we know, is less saccharine than new, and is more alcoholic and has a more agreeable smell, which is its characteristic. Even more has been done in different experiments made in various countries, especially in Italy, where must has been converted into old wine. M. Guarini remarked that the results are contradictory, doubtless because the different experimenters have not taken the cause of ageing into account. The following is the explanation that he gave. It is now admitted that the ageing of wine is due to an oxidation. If wine be electrolyzed, the principal phenomenon will be the decomposition of the water thereof into oxygen and hydrogen. Now, oxygen is our oxidizer and hydrogen the agent that reduces and precipitates the coloring matter. This latter point is in accordance with the experiment which demonstrates that wine treated electrically becomes decolorized. If things occur thus (and there is every

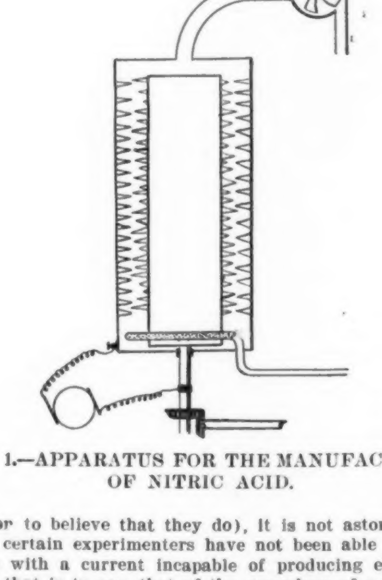


FIG. 1.—APPARATUS FOR THE MANUFACTURE OF NITRIC ACID.

reason to believe that they do), it is not astonishing that certain experimenters have not been able to age wine with a current incapable of producing electrolysis, that is to say, that of the secondary of a Ruhmkorff coil, an alternating arc of high tension.

C. Purification.—There are two ways of effecting the purification of liquids or juices electrically, viz.: (1) by electrolysis, with the employment of electrodes and electrolytes of special nature; and (2) by injecting ozone into the material to be purified. Both methods are, according to M. Guarini, equally good, although the choice is subordinate to local circumstances. In fact, with ozone we have need of a much weaker current than with electrolysis. For example, it requires 1/5 horse-power to purify a ton of saccharine juice with ozone, while with electrolysis it takes about 40 horsepower. On the contrary, an installation for purification with ozone is of high cost and is also quite complicated, while one for accomplishing the same thing by electrolysis is simple, and the cost is really insignificant. It is necessary, then, to make a selection according to circumstances. If the energy is cheap, the electrolytic process will be adopted; but, when the current is dear, the ozone method will be the one selected, and the more so in that it is possible to directly utilize the high tension alternating current supplied by a distant central station. As the ozone process is well known, M. Guarini did not dwell upon it. For the electrolytic purification of oils he recommended the Aspinwall, Hoar and Wice system (Fig. 2), which he said that he himself had successfully experimented with. In order to operate this apparatus, the oil must be rendered a conductor of electricity. Such a result is obtained by mixing an appropriate saline solution with it, and stirring the two well together. The oil thus prepared is afterward poured into an electrolyzing trough divided into two parts by a porous partition. Each compartment contains an electrode—the positive one of carbon and the negative of copper. These are connected with a dynamo giving a continuous current

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

of at least 6 volts. The positive electrode dips into a solution of common salt of the proper density. The oil, to which is added equal parts of the same solution, is contained in the negative compartment in which is placed the copper electrode. Since the partition is porous, it allows the current to pass, but the oil remains in the compartment into which it has been poured. If the purification is difficult, the oil may be heated, but not beyond 82 deg. C. It is the chlorine disengaged that becomes the purifier.

The advantages of the process it is unnecessary to emphasize, since the purer the oil, the less apt it is to become rancid, and the greater is its commercial value.

Water, as we know, is generally infected with pathogenic bacteria and other more or less dangerous micro-organisms. The matter is a serious one in the country, and more so than elsewhere, because the

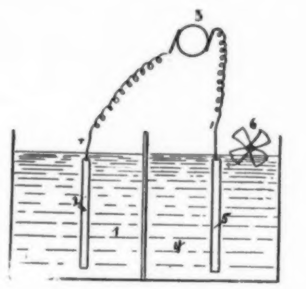


FIG. 2.—APPARATUS FOR THE ELECTROLYTIC PURIFICATION OF OIL.
1, Salt water; 2, cardboard; 3, dynamo; 4, oil with salt water; 5, copper; 6, stirrer.

water consumed there is often taken directly from polluted streams or stagnant ponds. When by chance it is drawn from a well, it is almost always infected by infiltrations from cesspools or the stagnant water of the vicinity. The most virulent microbes, those of typhoid fever, cholera, anthrax, tuberculosis, etc., are found therein in profusion and permanently. The field-hand is more or less immune from their attacks, but cattle are much less so. So certain diseases occur endemically and prevail among farm animals and sometimes degenerate into true epizootics, which ruin the owner. It is therefore exceedingly necessary for the protection of his material interests that the farmer shall see to the purity of the water consumed upon his property. Nothing is more easy than to have potable water on a farm provided with electric installations. It suffices, before using it, to filter and electrolyze all suspicious water; and this may be done as follows: The liquid is passed into an electrolyzer of which the negative pole consists of carbon plates and the positive of iron ores. The oxygen that accumulates at the positive pole attacks the iron and forms oxide which floats and which precipitates the organic materials.

In practice (Fig. 3) the water is forced from a reservoir into the electrolyzer, which is provided with plates of carbon and iron parallel with each other, at right angles with the current of water and connected with a dynamo. A pipe is fitted to the upper part of the electrolyzer to assure the exit of the foreign floating materials and oxide, while another is placed at the level of the upper electrode and leads the electrolyzed water to the filter. It requires about one ampere-hour to purify one cubic meter of water.

This process and others differing only in details are applied on a large scale at Amiens, Libourne, Boulogne-

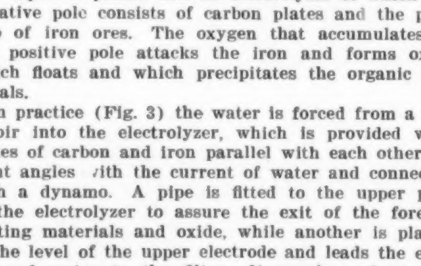


FIG. 3.—APPARATUS FOR THE ELECTROLYTIC PURIFICATION OF WATER.

sur-Mer, and at Philadelphia, where it is exploited by the Stanley Electric Company.

When saccharine juices are electrolyzed, the foreign matters separate from the saccharose. This is the property that is applied in the electrolytic processes of purification. These are at present divided into three groups, viz.: (1) The process by pure and simple electrolysis; (2) the processes by electrodialysis, in which the electrodes are separated by diaphragms in order to prevent chemical recombination; and (3) the processes by electro-hydrodisulphitation, based upon the production of hydrosulphurous acid (an energetic reducer of organic matters in saccharine solutions) by blowing sulphurous acid thereinto during the electrolysis.

The electric purification of saccharine juices gives the following results: a larger quantity of utilizable sugar, a sensible diminution of molasses, greater purity, better quality, and diminution in the time of the operation due to a diminution of the evaporation, which is easily explainable by the fact that a certain quantity of water is converted into oxygen and hydrogen gas.

According to M. Guarini the electric purification of saccharine juices sometimes costs less than that effected by the ordinary chemical processes, especially when a high tension current can be had at a low price. The net cost of a ton of saccharine juices purified by ozone may be estimated at 55 centimes, that is to say, 50 centimes for the sulphurous acid and barytes and 5 for current (½ horse-power), and interest on the capital. In the case of electrolysis (requiring 29 kilowatts), the net cost is lower when the current is cheap, since, practically, there is no other expense than that connected with the current. In the case of Niagara Falls, admitting that the current can be had *in situ* at 0.005 franc ($0.001) per kilowatt-hour, the purification of a ton of saccharine juice would cost but $0.005 \times 29 = 0.145$ franc ($0.029).

M. Guarini concluded by recapitulating the experiments made by M. Walter, in Russia, on the electrolytic synthesis of sugar, the crude material being carbonic acid. Agriculture, however, has as yet nothing to fear from this, since the process is still confined to the laboratory. Although electro-chemistry is full of promises for the future, it is more than certain that beet and cane sugar, especially the latter purified electrolytically, will be cheaper and better than that manufactured by electrolytic synthesis, admitting that the process ever becomes industrial.

SHALL WE ALL DIE OF THIRST?*

By J. E. WHITBY.

FROM earliest times humanity has been supposed to exist with the sword of Damocles over its head. Through long centuries the comparatively immediate destruction of the human race has been persistently prophesied, the only variation being in the make and shape of the weapon which should accomplish the catastrophe. Each of the elements in turn has been presented before our terrified eyes as the arbiter of our destiny, and we have only been reassured by the rainbow from the fear of drowning by a deluge to be confronted by the terror of a universal conflagration. While some savants consider the internal earth-fires as likely to make it unpleasantly warm for us one day, in consequence of the constant shrinking of the earth's crust, others warn us that in consequence of the expected vagaries in its old age of the Gulf Stream we shall perish from cold; while spirits more pessimistic still, foretelling the breaking loose from their formidable barriers of the icy waters of the poles, prophesy the extermination of all human life in a second glacial period.

To these warnings we have become somewhat accustomed, and, partly no doubt from our impotency to check, consider the future with resignation if not indifference. But we are also confronted with problems in the preservation of human life as a whole which we can control to a certain extent, and one of these is that of nourishment. The question as to whether, at the present rate of the increase of the world's population, there will in the near future be sufficient food, is one with which we are all familiar; but we console ourselves with the thought that by the time mouths are out of proportion to eatables some chemical compound will replace present-day nourishment. It is not merely food alone, however, which is likely to fail us, but, according to scientists, water; and though this may not strike the man on the black list as much to grieve over, the thoughtful will be struck by the trend of certain phenomena which have been recently brought to notice, and will perhaps anxiously inquire whether, while we are unable to control the mysterious laws of nature, some effort cannot be made at least to retard the annihilation of humanity by thirst.

It is well established nowadays that both in Africa and in Central Asia, and indeed in all the great levels of the world, the water-beds are drying up. A great number of lakes well known during the historical age have entirely disappeared; while in Africa, Lake Chiroua, to the southwest of Nyassa, has been shrinking during the last twenty years, and has now no place. Lake Ngami, which was discovered by Livingstone, exists no longer. Lake Tchad is now nothing but a half-dried-up water-bed. Turning to Australia—and in discussing this matter it will be noticed that only the important lakes, etc., are considered, though there are countless smaller depots of water, rivers, streams, and rills following the example—we find that Lake Eyre has greatly decreased in size.

Explorations in Central Asia have proved that for centuries a zone stretching from the east to the southeast of this part of the Czar's dominions has been drying up; deserts are gradually spreading, and reports show that it is only in the neighborhood of mountains, round whose brows vapor condenses and falls for the service of the agriculturist, that irrigation can be carried on or that life itself can be preserved.

Travelers have brought back news from east Turkestan of the ruins of fine cities, great monasteries, and remains of old irrigation-works which prove that two thousand years ago what is now a howling wilderness of sand was then a fruitful land, where man lived on the product of the soil. In western Turkestan the salt-lake of Char-Kel or Zembil-Koul is gradually drying.

The river Tarim, which was once one of the most frequented Asiatic routes, is now almost gone; and Lob-nor, which formerly covered an area four times as large as the Lake of Geneva, is now nothing but a shallow marsh, whose greatest depth is fifteen feet. Without naming the numerous deserts which were once habitable and peopled, and coming to a part of the world more generally known, it may be remarked that the Siberian lakes have greatly diminished both in the eighteenth and nineteenth centuries.

In European Russia large stretches of country that were once covered with water are now dry; and Novgorod, that modern scene of a busy commercial fair, where thousands of merchants congregate annually, was in the middle ages so surrounded by marsh that the Mongols, when sweeping the country, were unable to seize it.

According to Prince Kropotkin, the Russian savant, who has written much on the matter, all these effects may be referred to changes that have been going on since the remote geological epoch known as the glacial period. During that time a great part of northern Europe and Asia (to the fiftieth degree of latitude) was covered with thick ice, stretching to the valleys of the Don and Dnieper. When the ice retired, all the regions in those two parts of the world less than three thousand feet in height became submarine. In those days the Gulf of Finland stretched to Lake Ladoga, and was only separated from the Arctic Ocean by a narrow neck of land. The Caspian Sea reached to Lake Aral. The water, therefore, left by the glaciers has been and is being simply used up in different ways, Nature playing her usual reckless part. The Russian scientist has naturally devoted his examination of this phenomenon to his own country; but the reports which come from other lands nearer home bear out the same disquieting fact. Everywhere in our own country, as in others, water-springs are giving out and water-beds drying up, slowly perhaps, but surely. The increase of population and the modern system of drainage have, of course, a great deal to answer for; but much of the drought is undoubtedly caused by the rapid destruction of timber on all sides, for trees not only attract rain-clouds but preserve the moisture of the soil. While it is impossible for puny man to control the geological period through which we are passing, and whose characteristic would be—according to some—the gradual disappearance of water, it may be inquired whether it would not be advisable to postpone that disagreeable moment of a world without water as far as possible by the better preservation of our woods and forests and the persistent replanting of trees.

* Chambers's Journal.

ACTION OF METALS IN THE COLLOIDAL STATE ON THE EVOLUTION OF INFECTIOUS MALADIES.*

IT has already been shown by M. Trillat that it is possible to obtain combinations of manganese, alkali, and albumen having very decided oxidizing properties. Their oxidizing action is similar to that of the solutions of metals dissolved in the colloidal state in distilled water, according to the Bredig method, that is, by means of the electric spark.

The colloidal solutions experimented on by M. Trillat are prepared by making in distilled water a three per cent albuminous solution of the albumen of the white of fresh eggs; this is filtered, two centigrammes of chloride of manganese are added, then 0.1 per cent of soda or potash. The manipulation should be sheltered from the air. A precipitate is formed, which immediately redissolves, and the liquid is put into tubes.

The alkali must be added last in order that the manganese may be kept in the colloidal state. Similar liquids may be obtained with other metals.

MM. Robin and Bardet consider that the colloidal metals are susceptible of favoring organic oxidations, and thus of moderating the symptoms of infection or morbid intoxication in the same way as the natural oxydases, and they have also experimented with the artificial oxydases prepared according to the Trillat method referred to above.

The colloidal metals (silver, gold, platinum, and palladium), prepared by the Bredig method, have been tested in scarlatina, severe grip, aggravated jaundice, typhoid fever, tuberculosis, and pneumonia. In all these experiments the chemical changes of composition connected with respiration have shown that there is excitation of the intraorganic exchanges. The same phenomenon has been manifested by the urinary changes; the urea increases in such proportions that, in certain cases, the addition of nitric acid to the urine gives rise to the formation of crystals of nitrate of urea; there is also augmentation of the uric acid and production of an increasing quantity of urinary indoxyle. These phenomena are especially noticeable in pneumonia.

With the oxydase of beer yeast results were the same, but less marked. With the Trillat liquids, prepared with manganese and with copper, the effects were also the same, but less intense (especially for the manganese) than with the colloidal metals prepared according to the Bredig method.

In pneumonia and infectious maladies, the phenomenon known as *defervescence* or *favorable crisis*, is always accompanied with a considerable increase of the eliminated urea, and also with an over-production of uric acid, indicating important leucocytotic influence. These symptoms are followed by amelioration of the patient's condition. The same results are obtained with the colloidal metals and the artificial oxydases of M. Trillat.

MM. Robin and Bardet have also obtained with the manganic oxydase of M. Trillat an amelioration of the

* Condensed from the French of MM. Robin and Bardet. Communication to the Académie des Sciences.

condition of patients attacked by tuberculous meningitis.

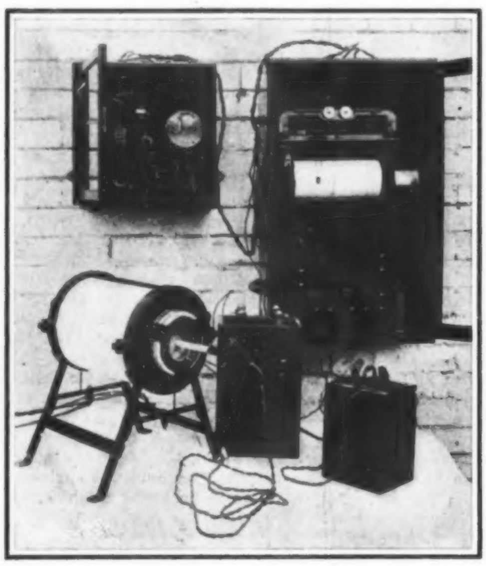
As is well known, it has been proposed to treat pneumonia with anti-diphtheria serum and with the serum of the horse; these serums evidently act by virtue of the oxydases which they contain; the analogous action of the artificial oxydases allows of assimilating these with therapeutic serums.

THERMOMETERS AND PYROMETERS, WITH SOME OF THEIR INDUSTRIAL APPLICATIONS.*

An interesting lecture was recently delivered before the Cleveland Institution of Engineers (England) by Mr. Robert Whipple, describing thermometers and pyrometers, with some of their industrial applications. Mr. Whipple has long been identified with this branch of scientific investigation, and has personally devised some ingenious and valuable apparatus for the measurement of temperature, many of which from time to time have been described in the SCIENTIFIC AMERICAN SUPPLEMENT.

The accurate measurement of temperature is still a problem of considerable difficulty. Temperature is not a measurable quantity in the strict sense of the term. To measure a length or a mass is to count how many times it is necessary to take a given body chosen as a unit (meter or gramme, as the case may be) in order to obtain a system equivalent, either as to length or mass, of the body in question. The possibility of such a measurement assumes the existence of two laws—that of equality and that of addition. Temperature obeys the first of these laws. Two bodies in temperature equilibrium with a third will also be in equilibrium with each other. The other law is entirely lacking. The simple operation of placing together several bodies at one temperature does not result in the realization of a system equivalent from the point of view of exchange of heat to a body at a different temperature.

Many scales of temperature have been suggested, but the gas scale is now the one universally adopted, and readings obtained by any type of thermometer—electrical, expansion, or optical—are reduced to temperatures on this basis. The gas scale has been adopted as the standard scale of temperature for three reasons: (1) Because gas of the same purity can be reproduced at any time; (2) the dilation of the gas, which defines the scale of temperature, is sufficient for accurate measurement; and (3) the scale is practically identical with the thermo-dynamic scale.



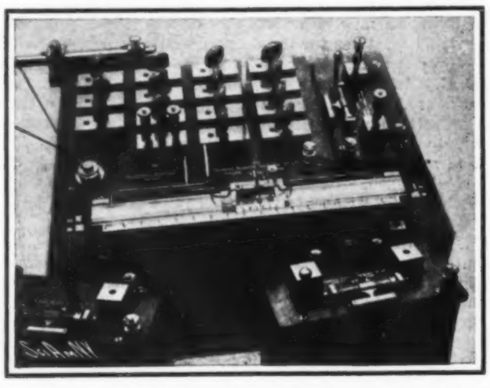
CALLENDAR RECORDER FOR DETERMINING THE RECALESCENT POWER OF STEEL.

Can be used either with a thermometer or a resistance thermometer.

Although the scale of the gas thermometer has become the standard of reference, yet it is not essential to use the gas-thermometer in every-day life. We do not employ an elaborate gas-thermometer, with its adjuncts of telescopes, microscopes, and standard barometer, every time it is desired to measure a temperature, but a thermometer which has been carefully standardized at certain known temperatures is utilized. Thermometers—and with thermometers are included pyrometers—are generally standardized by means of fixed points of fusion and ebullition, which have been determined by the gas-thermometer.

It is, perhaps, for this very reason that many of the discrepancies in high-temperature thermometry have arisen. The actual precision of the high-temperature measurements depend on the accuracy to which these points are known. It has at present been found impossible to determine many of these directly on the gas-thermometer, as even the platinum-iridium bulb of this instrument becomes porous at extremely high temperatures. High-temperature thermometry is badly handicapped through the scarcity of materials capable of being made into a thermometer bulb and of standing high temperatures. Platinum—the great stand-by—has been shown by Sainte-Claire Deville and others to be very permeable to hydrogen—a gas which is generally present where combustion is incomplete. Fortunately, platinum, even when red hot, is practically impervious to all other gases; so that if nitrogen is employed as the gas whose volume is being measured, and the platinum is suitably protected from hydrogen, accurate observation may be made. Porcelain must be glazed to insure non-permeability, and the glaze cannot be considered impermeable above 1,100 deg. C. Water vapor passes comparatively rapidly through unglazed porcelain.

The gas-thermometer, although invaluable from the strictly scientific point of view, is practically useless as a tool in every-day life. It will be well, therefore, to summarize roughly the various means of measuring temperature in general use.



CALLENDAR AND GRIFFITHS' WHEATSTONE BRIDGE RESISTANCE THERMOMETER FOR EXTREMELY ACCURATE MEASUREMENTS.

Expansion Thermometers.—Although the gas-thermometer is essentially an expansion instrument, the mercury in glass thermometer is the expansion instrument *par excellence*. It is now possible to measure temperature with a mercury thermometer with an accuracy of 0.0001 deg. Cent. Yet notwithstanding the high standard of perfection to which this apparatus has been brought, it possesses some inherent disadvantages.

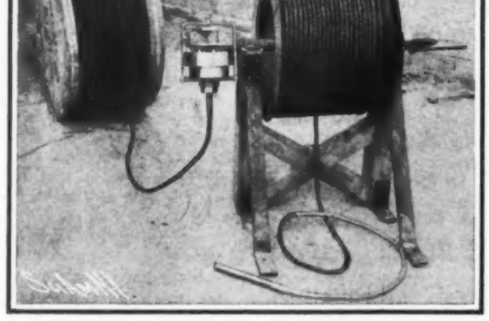
The various errors found in a mercury thermometer of the best construction, and the methods of determining the corrections to allow for them, may be briefly set forth as follows:

1. Correction for Parallax and Refraction.—The divisions of the scale on the stem of a thermometer are not exactly adjacent to the mercury thread, and consequently the readings will vary somewhat with the direction of the line of sight. This error is best eliminated by taking the mean of the readings when the scale is on the side nearest the observer, and again when placed opposite. Unfortunately, this necessitates dispensing with the enamel back in the case of very accurate thermometers.

2. Scale and Calibration Corrections.—It is impossible to obtain a tube or stem of absolutely uniform bore. It follows, therefore, that the size of a degree division must vary throughout the tube. The error arising from this inequality in the bore can be accurately determined by measuring the length of a small thread of mercury in scale divisions in various portions of the stem.

3. Determination of the Boiling Point.—Care must be taken in the determination of this point, the whole thermometer being enveloped in steam, which is allowed to pass freely into the open air. It is important that the barometer reading should be determined accurately—a difference of 0.14 millimeter in height of the barometer making a difference of 0.005 deg. Cent. in the boiling point.

4. Determination of the Freezing Point.—The stem as well as the bulb of the thermometer should be in finely-chopped ice, which should be as pure as possible.



THE THERMOMETER SHOWING CABLE DRUMS AND MERCURY CUP.

For recording temperature of Loch Ness at a depth of 900 feet, the temperature being recorded on an instrument 1200 feet from thermometer.

5. Corrections for Different Temperature of Scale or Stem.—In the case of thermometers with brass scales in which the bulb, scale, and stem have different temperature coefficients of expansion, large errors may be introduced by not correcting the scales for temperature. In accurate thermometers the same correction has to be applied to the glass scale. Errors amounting to a quarter of a degree may be introduced by not allowing for the expansion of the mercury thread in the capillary bore.

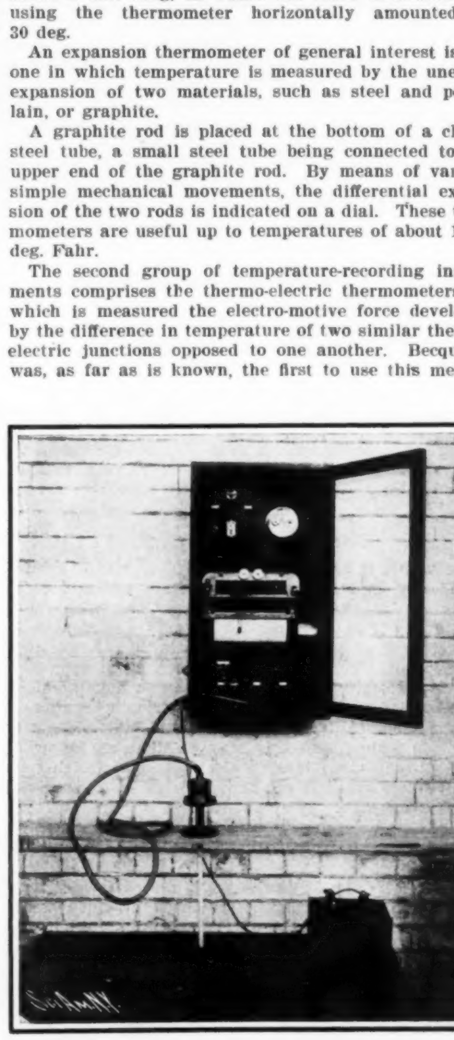
6. Correction for Pressure of the Bulb.—There is an external and internal pressure on the thin glass of the bulb. At high elevations above sea level, when the atmospheric pressure is reduced, the error introduced becomes of importance, but for general use it may be neglected.

In long-stem thermometers the error introduced by using horizontally a thermometer which has been calibrated vertically, becomes of importance. Mr. Whipple relates that he once examined a mercury thermometer about 9 feet long, in which the error introduced by using the thermometer horizontally amounted to 30 deg.

An expansion thermometer of general interest is the one in which temperature is measured by the unequal expansion of two materials, such as steel and porcelain, or graphite.

A graphite rod is placed at the bottom of a closed steel tube, a small steel tube being connected to the upper end of the graphite rod. By means of various simple mechanical movements, the differential expansion of the two rods is indicated on a dial. These thermometers are useful up to temperatures of about 1,200 deg. Fahr.

The second group of temperature-recording instruments comprises the thermo-electric thermometers, in which is measured the electro-motive force developed by the difference in temperature of two similar thermo-electric junctions opposed to one another. Becquerel was, as far as is known, the first to use this method of measuring high temperatures (1830). He used a platinum-palladium couple. His son, Edmund Becquerel, was the first to realize the importance of using a high-resistance galvanometer with a thermo-couple. The electromotive force is a function of the temperature, and as it is the current that is measured, it is important that the resistance of the whole circuit should be as nearly as possible constant; that is to say, the change in resistance of the couple itself should be small as compared with the change in the rest of the circuit. Of all the couples, those consisting of platinum, and an alloy of platinum with 10 per cent of rhodium, are durable for use at extremely high temperatures. On the other hand, a platinum, platinum 10 per cent iridium, couple gives a larger electromotive force, and therefore a more open scale.



ELECTRICAL CONNECTIONS OF THERMOMETER, CALLENDAR'S PYROMETER AND CONTINUOUS RECORDER.

Two methods are generally employed to measure the electromotive force of a couple; the potentiometric, or the method of compensation, and the galvanometric. The first method is rather cumbrous for general workshop use, but it is undoubtedly the more accurate.

The galvanometric method is simplicity itself, the cold ends of the thermo-couple wires being connected directly to the galvanometer terminals. If the resistance of the circuit is constant, the deflections will be proportional to the electromotive force. The majority of direct-reading instruments consist of a sensitive D'Arsonval galvanometer, the coil of which either carries a mirror reflecting a spot of light onto a scale or a boom pointing to a scale. One of our cuts illustrates a recent form of platinum and platinum-rhodium couple made by the Cambridge Scientific Co., Ltd. The couple is connected directly to a milli-voltmeter, the scale of which is divided in milli-volts and degrees Centigrade.

A simple form of recorder is one in which the pointer of the galvanometer carrying at its end some device for puncturing the record sheet, or a pen, moves across

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

the paper. The pointer is pressed down on the record sheet every minute, and makes a point corresponding to the deflection of the galvanometer (i. e., the temperature at that instant).

The two methods of thermo-couple measurement may be compared as follows:

The advantages of the galvanometric method are portability and simplicity; the disadvantages, closeness of scale and the fact that an error is introduced by the variation in resistance of the couple. The potentiometric method has the advantages of an open scale, and that no error is introduced by the resistance of the couple. The only serious disadvantage is the fact that the apparatus must be worked in a laboratory, and requires a trained observer.

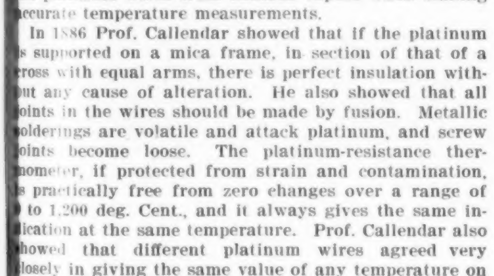
Prof. H. L. Callendar, however, has designed an interesting recording potentiometer for use with thermocouples.

An extremely ingenious method has been designed by Dr. Stansfield for obtaining sensitive records of recalescent points. Two junctions are employed; one is placed in the piece of steel, and the other in a piece of fine clay or copper. A sensitive galvanometer, connected to both thermo-junctions, measures on a large scale the difference between the temperatures of the steel and the clay or copper. Magnified records of the evolution of heat in the steel can thus be obtained, which are not affected by the general fall of temperature of the system.

Electric-Resistance Thermometers.—The electric-resistance thermometer was first proposed by Sir William Siemens in the Bakerian Lecture of 1871, and it immediately came into general use in metallurgical work. Unfortunately, it was found that the pyrometer did not satisfy the fundamental criterion of always giving the same indication at the same temperature, and it was rather severely condemned by a committee of the British Association in 1874, who showed that these changes in resistance were due to chemical alterations in the platinum. These changes are very rapid if the platinum is quite unprotected, less rapid if the platinum is protected by a steel tube, and disappear if protected by a porcelain tube. All the volatile metals attack platinum readily, and silica and the silicates must be avoided. We recently experienced a striking case of the weakness of platinum in this respect. A thermometer was constructed, the outer covering of which was a nickel tube turned out of a casting, and presumably porous. The furnace gases passed through the nickel tube, and rapidly destroyed the platinum. What actually occurred is not quite clear, but chemical analysis showed that the platinum leads were found to be largely impregnated with iron. It has been suggested that volatile nickel carbonyl was first formed, which combined with the iron tube of the upper part of the thermometer, forming iron carbonyl which, in its turn, combined with the platinum. Whatever occurred, the thermometer was rendered worthless after comparatively little use. I mention this case in order to emphasize the care that should be taken to protect the platinum wires from noxious vapors when making accurate temperature measurements.

In 1886 Prof. Callendar showed that if the platinum is supported on a mica frame, in section of that of a cross with equal arms, there is perfect insulation without any cause of alteration. He also showed that all joints in the wires should be made by fusion. Metallic solderings are volatile and attack platinum, and screw joints become loose. The platinum-resistance thermometer, if protected from strain and contamination, is practically free from zero changes over a range of 0 to 1,200 deg. Cent., and it always gives the same indication at the same temperature. Prof. Callendar also showed that different platinum wires agreed very closely in giving the same value of any temperature on the platinum scale, although they differed considerably in the values of their temperature coefficients.

He also pointed out that if R_0 denote the resistance of the spiral of a particular platinum thermometer at 0 deg., and R_1 its resistance at 100 deg., we may establish for the particular wire a temperature scale, which we may call the scale of platinum temperatures, such that if R be the resistance of any temperature on



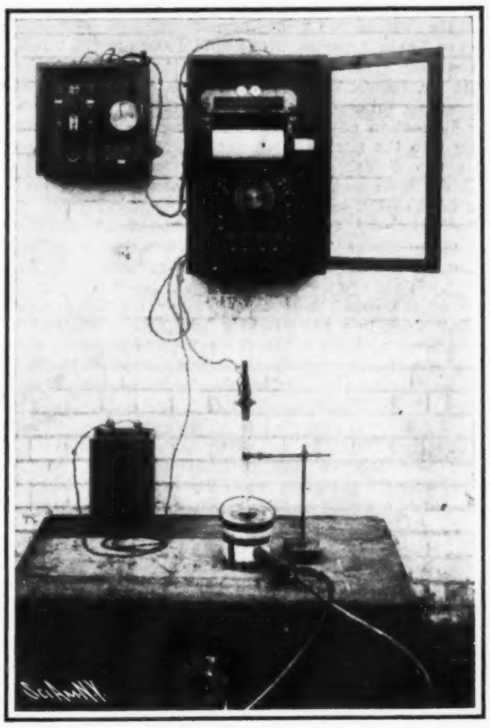
THE MOST RECENT FORM OF PLATINUM-RHODIUM COUPLE.

the air scale, the temperature on the platinum will be $\frac{R - R_0}{R_1 - R_0} \times 100$. For this quantity he employs the symbol pt, its value depending on the sample of platinum chosen. In order to reduce temperatures on the platinum scale to the gas scale, it is necessary to know the law connecting T and pt. They are, of course, identical at 0° and 100°, and experiment has shown that the formula

$$T - pt = \delta\left[\left(\frac{T}{100}\right)^2 - \frac{T}{100}\right]$$

depresses the curve of the relationship between them in other parts of the scale. The value of δ depends on the purity of the platinum used; it can be obtained from observations at three known temperatures. A table of corrections is used to convert temperatures on the platinum scale to those on the gas scale, or the instruments used with the thermometers read directly on the gas scale.

The platinum-resistance thermometer consists of a



A RESISTANCE THERMOMETER IN A CRUCIBLE PLACED IN A GAS-MUFFLE.

fine platinum wire wound on a mica frame, connected by means of stout copper or platinum leads to terminals in the head of the thermometer. Two similar leads, but unconnected to the coil, pass through the whole length of the thermometer, and act as compensating leads. By this means no error is introduced by the variation of the temperature of the wires connecting the thermometer with the indicator or recorder. The general arrangement for the use of Callendar and Griffiths' resistance thermometer is to make the thermometer coil form one arm of the bridge, while the compensating leads and the balancing coils form the opposite arm. A pair of equal-ratio arms are generally used.

If temperature measurements are to be made with a resistance thermometer to a high degree of accuracy, a specially-designed Wheatstone bridge and a sensitive galvanometer must be employed. Mr. Whipple has designed a bridge which is a modification of one invented by Prof. Callendar and Principal Griffiths, in which the temperature values are read directly in degrees Centigrade, and rapidly-varying temperatures may be followed. The instrument is especially useful for measuring the temperatures of boiler flues, general testing and annealing work, etc.

The recording apparatus designed by Prof. Callendar consists of a Wheatstone bridge or potentiometer, in which the movement of the slider along the bridge wire is automatically effected by delicate relays worked by the current passing through the galvanometer between the bridge arms. According as the moving of this galvanometer is deflected in one direction or the other, a relay circuit is connected through one or other of two electro-magnets. Each of these magnets is mounted on a clock, the movement of which is prevented by a brake. When a current passes through a magnet, this brake is lifted, allowing the clockwork to revolve. The clocks are connected by differential gearing with a recording pen, which is pulled in one direction or the other, according as the brake is lifted from the corresponding clock. The bridge slide moves with the pen, and tends to restore balance.

A Callendar recorder for determining the recalescent points of steels and for general thermometric work can be used either with a thermo-couple or with a resistance thermometer. The two electro-magnets referred to can be seen in the top portion of the large box. The galvanometer is mounted in a separate case, in order that the pen may be adjusted, coils be removed, etc., without shaking the galvanometer. The thermometer is shown inserted in a block of steel in the small gas muffle.

Mr. Whipple contends that the Callendar recorder provides the most satisfactory way of mechanically drawing a temperature record. The uses to which a satisfactory recorder can be put are almost innumerable.

The "heat recalescent" of steel is a common topic of conversation among engineers, and anyone who has had anything to do with annealing knows the difficulty of maintaining the ovens or furnaces at a constant temperature. These recorders, however, overcome the difficulty. The difference in the firing between two men—the old, experienced hand and the new man who fires more frequently—is very striking. The thermometer is provided with a heavy cast-iron head having a large iron flange, which rests on the cover of the furnace. Resistance thermometers, however, are now being used for more strictly scientific work, and a thermometer of this type may be made extremely sensitive.

In the latter part of 1903 Sir John Murray made a series of experiments to determine the temperature of Loch Ness. The thermometer was immersed to a depth of 200 feet, and the temperature was recorded on an instrument at a distance of 1,200 feet from the thermometer. The thermometer was attached to a cable wound on a drum, which was fixed to the deck of a boat moored in the loch, and the cable was connected to the shore cable by means of an elaborate mercury cup.

Heat-Radiation and Optical Thermometers.—Many workers have endeavored to evolve a pyrometer that would measure the temperature of a source of heat without the necessity of inserting a "poker," as the Americans call the ordinary pyrometer.

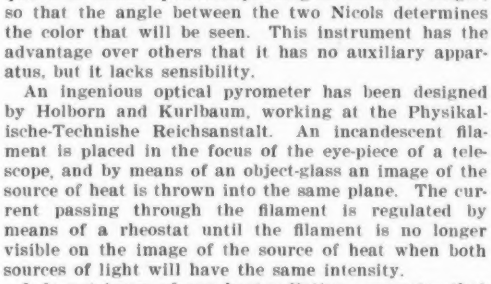
Taking optical thermometers first, Mr. Whipple thinks that on the whole the one designed by Prof. Wanner is the most successful. It is based on the photometric comparison of the intensity of light emitted by the incandescent body whose temperature is sought, with the light of a standard comparison lamp. Instead of using monochromatic light, the light is spread out into a spectrum by a direct-vision spectroscope, and a small region in the red is used. The working standard source of light is a small incandescent lamp. The method of reducing the two fields of light from the hot body and the electric light respectively to the same intensity, is first to polarize them in planes at right angles to each other, and then the intensity of each can be varied by viewing them through Nicol's prism, which can be rotated. The angular rotation of the Nicol is then a measure of the intensity of the light, and therefore of the temperature. The incandescent lamp can be standardized against an amyl-acetate flame. Owing to the loss of light in the optical system of the pyrometer, the lower limit of temperature measurement with the Wanner is about 900 deg. Cent., so that it unfortunately cannot be used for determining the hardening and annealing temperatures of many steels. The instrument is capable of considerable accuracy, it being possible to obtain temperature measurements with it to within one per cent.

In Mesuré and Nouel's pyrometer telescope, an attempt is made to control temperatures by taking advantage of the rotation of the plane of polarization of light passing through a quartz plate cut perpendicular to its axis. The angle of rotation is directly proportional to the thickness of the quartz, and approximately inversely proportional to the square of the wave length.

In general, the field of view will be colored, and by turning the analyzer, the color observed will change because the light, all polarized in the same plane, emerging from the first Nicol is polarized by the quartz in various planes depending on the wave length, so that the angle between the two Nicols determines the color that will be seen. This instrument has the advantage over others that it has no auxiliary apparatus, but it lacks sensibility.

An ingenious optical pyrometer has been designed by Holborn and Kurlbaum, working at the Physikalische-Technishe Reichsanstalt. An incandescent filament is placed in the focus of the eye-piece of a telescope, and by means of an object-glass an image of the source of heat is thrown into the same plane. The current passing through the filament is regulated by means of a rheostat until the filament is no longer visible on the image of the source of heat when both sources of light will have the same intensity.

I do not know of any heat-radiation pyrometer that has been successfully applied commercially. Boys' radio-micrometer, although marvelously sensitive, is too delicate for the rough handling of every-day life. It consists of a loop of copper wire hung in a magnetic



A SIMPLIFIED BRIDGE RESISTANCE THERMOMETER DEVISED BY MR. WHIPPLE FOR COMMERCIAL APPLICATION.

field, the two ends of the wire being connected to small plates of bismuth and antimony respectively, and a small copper plate being attached to the junctions. The heat radiation is allowed to fall upon this copper plate. A small electric current is generated, and the loop, which is suspended by a delicate quartz fiber, turns, carrying with it a light mirror. Some extremely interesting work has been carried out with one of these instruments; Dr. W. E. Wilson has, for instance, concluded that, supposing the sun to be a dark body, its temperature would be 6,590 deg. Cent.

Prof. Langley designed a radiometric apparatus under the name of a bolometer, which has since been largely developed by Prof. Callendar for measuring heat radiations, more particularly solar radiations. It consists of a differential pair of flat platinum thermometers, one blackened and the other bright, placed side by side in the same horizontal plane in a hermetically-sealed glass vessel. The difference of temperature between the two, which is automatically recorded on a Callendar electric recorder, is approximately a measure of the intensity of the vertical component of the radiation to which they are exposed. It has already been shown with these instruments that the heat received by reflection from the sky under certain conditions may amount to more than 40 per cent of the whole vertical component. They have also shown what a large proportion the negative radiation bears to the amount of radiation falling on the earth during the day. The radiation is continually varying throughout the whole night. These instruments have been successfully employed to measure boiler radiation, more especially to compare the relative efficiency of various boiler laggings.

The Siemens water calorimeter is well known. A ball of copper, iron, or platinum of known weight is exposed to the heat of a furnace, and is then transferred to a vessel containing a measured quantity of water at a known temperature. It can readily be seen that, knowing the rise in the temperature of the water, owing to the insertion of the hot body, and the specific heat of the metal ball employed, the temperature of the furnace can be deduced.

Discrepancies have long been observed between the results obtained with water calorimeters and other forms of pyrometers; but these discrepancies have now been accounted for.

Fusion Thermometer.—Reference must be made to the excellent work of Seger in producing a series of porcelain cones melting at various temperatures, and to the work of Mr. Henry Watkin in the same direction. An ingenious device has also been invented by Messrs. E. H. Griffiths and W. C. D. Whetham. An iron rod is held rigidly in a steel tube by means of an alloy melting at any given temperature. The rod is free to rotate as soon as the alloy is melted, and can be made to ring an alarm either mechanically or electrically or to shut off gas, steam, etc. By a simple contrivance it can easily be reset for another experiment.

SAGHALIEN, THE ISLE OF THE RUSSIAN BANISHED.

By W. C. CHISHOLM.

IN these days when transcontinental railways and speedy ocean-transit have given a great impetus to travel, and enterprising spirits, led on by the love of adventure or bent upon the advancement of science or commerce, have pressed far afield from the beaten tracks into countries of which little save their names was known, it is no small distinction to be a pioneer-traveler and give to the world authentic information about peoples and places concerning which rumor had been busy, but which had been unvisited by the explorer.

Such a distinction has been won recently by Mr. Charles Hawes, who in 1900 started on a tour which included India, Australia, New Zealand, China, Japan, and Siberia; and it was in connection with his explorations and investigations in Saghalien, or Sakhalin, that he made his mark. Fond of travel and gifted with an aptitude for languages, Mr. Hawes had visited most European countries before he started on his long tour, which he undertook partly as a fitting complement to a university education, and partly as a valuable preparation for public life. Australia and New Zealand, usually neglected by the globe-trotter, who finds his chief fascination in the Orient, were included in his programme because there he hoped to see what an advanced democracy was accomplishing; while in India it was his purpose to study the working of a benevolent despotism modified only by the public opinion of a nation which believes in representative government. Only the fringe of the vast Chinese Empire was touched by visits to the treaty ports; and as illustrating the variety of its languages and dialects, of which those who have not traveled in the East have no conception, Mr. Hawes mentioned to the writer the following incident. He was staying with a friend in the hinterland of Hongkong when the latter had occasion to engage a second "boy." They were in Hakkaland, and he sent "boy" No. 1 some ten miles to interview and bring along "boy" No. 2; instead of which he returned, with tears in his eyes, to explain that he had not been able to make the other "boy" understand: he spoke another language. The time available for Japan proved all too short for the traveler to compass his purpose of making even a hurried investigation of its government and administration, and of the industrial reform movement, so drawn away was he by the natural beauty of the country and the art productions of the people. Moreover, he was bent upon visiting Siberia; and to remain longer in the Island Empire would have meant his abandoning one of the chief items of his programme.

Siberia may not have an attractive sound for the ordinary traveler, but Mr. Hawes included it in his tour inasmuch as he was anxious to solve the question whether or not the treatment of the exiles and convicts by the Russian government was such as was depicted by the attackers or defenders of that administration. His study of the question had informed him that on the island of Saghalien, separated from the mainland by the Straits of Tartary, and from northern Japan by La Pérouse Straits, he would find Russia's worst criminals, and had led him to believe that he would discover a state of things approximating to the condition on the mainland fifteen years ago. Further, there were primitive tribes on the island of whose history and habits next to nothing was known, and his leaning toward the study of ethnology confirmed him in his desire to reach them and place on record an authentic account of their manners, customs, and traditions ere they were overtaken by the well-nigh inevitable fate of the aborigines, whether in New Zealand or North America, who dwindle and die out before the steady advance of the white man. The story of what Mr. Hawes saw in Saghalien is told in his most interesting volume, "In the Uttermost East," and his is the distinction of being the first Englishman to penetrate into the northeastern portion of the island and visit the Gilyak and Orochon tribes. For reasons which will be mentioned later, he was unable to visit any of the Ainu settlements.

Saghalien—or, to use the Russian official spelling, Sakhalin—means "black," and it is indeed a fitting name for the most notorious penal settlement in the world. Black are the crimes which brought large numbers of the convicts to that "dreary isle of punishment," black in many respects has the administration often been, and black are the prospects of those outcasts of humanity who have been deported to the farthermost portion of the empire, from whose sea-girt shores there is but the slenderest prospect of return. Its very name is under a ban at St. Petersburg, and so evil is its reputation that to receive an appointment there is a stigma. The Russian occupation of the island dates from 1852, when its acquisition became necessary to guard the entrance to the river Amur, where the Russian flag had been placed in the previous year; and so inhospitable a spot was it, and such were the difficulties and dangers of navigating its coast and effecting a landing, that it was not until 1849 that it was discovered by Capt. Nevelsky, who was searching for a naval base in eastern Siberia, to be an island. Up to that time it had been regarded by the civilized world as a peninsula and part of the Chinese mainland.

In size it is somewhat less than Scotland, having an area of about twenty-nine thousand three hundred and thirty-six miles. It extreme length is five hundred and ninety miles, while in breadth it varies from seventeen to one hundred miles. The greater part of the island is covered with primeval forests of such density that even the natives do not track them, but rely chiefly upon the rivers as their highways; in the summer traversing them in canoes dug out of the trunks of trees, in the management of which they are most expert, and in the winter traveling over their frozen surface in sledges drawn by dogs or reindeer. So sparsely is the country populated that on a journey to the east coast by the route most used by the natives, Mr. Hawes for three days saw not a single person or dwelling. The heat in summer is considerable, and the winters are long and severe. Snow may be expected about the middle of October, and generally lies for one hundred and seventy or one hundred and eighty days. By the beginning or middle of November the Straits of Tartary begin to freeze, and are closed to navigation for about six months. Then, were it not for the cable, the inhabitants would be cut off entirely from the rest of the world until the ice was thick enough to allow dog-sledges to cross to the mainland; but as that is not possible, as a rule, until at least the end of December, and as the cable was broken for months before and after Mr. Hawes's visit, the connection is at the best precarious, and the isolation sometimes complete.

Mr. Hawes found that the climate of the country has been much maligned. Far from fogs being prevalent, as the reports of mariners had led him to expect, he discovered that, while they are very frequent at sea, a margin of four miles from the shore is generally clear; and during the seven weeks he was on the island there was not a single fog, and often the coast-line of the continent, sixty miles distant, was clearly visible. In fact, the average annual cloudiness and rainfall is much less, while the sunshine is considerably more, than that recorded in England.

Fish—especially salmon, which forms the natives' staple article of food—abound in the larger rivers. Reindeer, foxes, sables, and otters are found in considerable numbers, and wolves still exist in the south; but the most striking animal in Saghalien is the big brown bear, which plays an important part in the religious ceremonies of the Gilyaks.

According to the latest statistics available when Mr. Hawes was there, the total population of the island in 1898 was about thirty-six thousand. Of that number only about one-eighth were natives, the remainder being Russian officials and convicts, and a few wives of prisoners who voluntarily had followed them to that terrible prison-land from which hope is almost wholly banished.

For administrative purposes the island is divided into three districts, each presided over by a chief, subject to the military governor; martial law obtains everywhere. The Russian occupation, however, is really confined to those districts of which Alexandrovsk on the west coast and Korsakovsk on the south are the centers, while the biggest prison is at the former town, where the governor resides. It was at Alexandrovsk that Mr. Hawes had facilities such as had not been enjoyed by any European traveler for observing the everyday life of the convicts and the political exiles; and his impressions of the results of the penal system as it exists there, and the records of what he saw, form an intensely interesting part of his valuable book. The political exiles, it should be said, form but a small part of the population; and as they generally have been well educated and are quiet in prison, they are soon promoted, and find employment as doctors, school-teachers, bookkeepers, or metallurgists. As, however, they are entirely dependent upon the caprice of the officials as to the places they are sent to, the posts they fill, and the remuneration they receive, their existence is precarious in the extreme, and many have the greatest difficulty in pulling through.

The Russian law with regard to deportation is severe. "It provides that any criminal with a sentence of not less than two years and eight months, any woman (not exceeding forty years of age) with a sentence of two years and over, and any political exile (at the discretion of the government) may be deported to Saghalien." In 1898 the number of men and women on the island who had been sent out as convicts was nineteen thousand seven hundred and seventy and two thousand three hundred and ninety-seven respectively, and according to an invariable rule, they had been classified according to their sentences. Those who have sentences of twelve years or upward are put into the worst or "testing" prison. That class consists chiefly of murderers, and, sad to say, a considerable proportion are women. Executions, except for regicide, are very rare in Russia, and even in Saghalien the punishment for murder is seldom death save if the victim is an official, or if the culprit is a member of a desperate band of criminals, or if the crime has been carried out with exceptional brutality. The next class includes those whose sentence varies from four to twelve years, and they are placed in the "reformatory" prison; while those whose sentences are less than four years are treated, after a short term, as "free commands." The ordinary course is for promotion, according to good behavior, to take place from one class to another, the average length of service in each class being a third of the original sentence. One of the weak points in the system is that a large number of those who belong to the worst or "testing" prison are kept in enforced idleness, and thus fall into yet deeper moral degradation; while others, under the charge of soldiers or of overseers who are ex-convicts, are sent to work in the coal-mines or on the jetty. The third class, or "free commands," are really men and women who are on "ticket of leave," and they go daily to the prison to have their work assigned. The best hope for a convict in Saghalien lies in his wife's following him; for should she do so he is at once transferred from the "testing" prison to a "free command," even although his crime is murder.

Another and most dangerous section of the criminal population consists of the *brodyagi*, or escaped convicts; and as it is by no means easy to track and capture them in the thick bush, to which they at once make their way, many succeed in eluding the authorities; and as they think nothing of committing a murder for the sake of a few kopecks or even a pair of old shoes, they are a terrible scourge to the island. Others, however, are soon forced by hunger to surrender themselves, while many fall into the hands of the soldiers or of native trackers, and having no passport, are handed over to the officials. But even then, strange as it may seem, a few of them succeed in avoiding serving their long term of punishment by having made such a bold bid for freedom; for if the *brodyagi* cannot be identified and they profess to have forgotten who they are and from what district they came, they escape with a punishment of only four years! Is it much wonder, then, that the most desperate of the convicts are on the watch for an opportunity to escape, being willing to run the risk of a flogging and an additional sentence, which may range from a quarter to the whole of the original term, if they are identified.

Flogging for theft, attempts to escape, and deeds of violence is still in force, although the *knut*, with its six-foot thong and bags of lead attached, has been abolished. Women, according to the law, are immune from corporal punishment; but in Saghalien, if they provoke the resentment of brutal officials, they do not always escape it. Another peculiarly degrading form of punishment, abolished on the mainland, but still resorted to in Saghalien in the case of the most desperate convicts, is that of being chained to wheelbarrows day and night.

Though there is promotion from class to class and consequently some slight amelioration of the lot of the convicts, it must not be supposed that on the expiration of their sentence they are free to return to Russia. Nothing of the kind. The island is, indeed, one vast prison, and of those who are deported there not more than one in a hundred ever succeeds in quitting it. To be sent to it is, for most, an edict of perpetual banishment; for the ex-convict must remain in Saghalien as an "exile-settler" for six years after his prison days are over, unless he has the promise of employment on the mainland, in which case the chief of the district may grant him leave to go. But in Siberia he must remain yet another six years as a "peasant," and in no case can he return to Russia within twelve years after he has served his full term.

It is easy to understand what the moral condition and atmosphere of such a community must be. Refining influences on the island, until recently, there have been almost none; for the government makes no direct attempt to reform the convicts through the priests. Every year about sixteen hundred prisoners arrive, and the children born on the island are brought up among surroundings of the greatest immorality and crime. Neither person nor property is safe. Murder is committed on the slightest provocation and for the sake of

the smallest gain; and in the frequent brawls of the "exile-settlers," even if life be endangered, the officials seldom interfere. If death results, what does it matter? There is one convict less! It was to the hospitality and tender mercies of such desperadoes that Mr. Hawes often had to trust himself. A revolver was an absolute necessity, even if he was going only a couple of yards from his abode. Outside the town it was well to carry a rifle in addition; while on his journey to the northeast of the island, to which he was the first white man to penetrate, he and his interpreter, himself an ex-convict, were rowed part of the distance by two settlers of the lowest type, and it speaks volumes for Mr. Hawes's nerve that he should have ventured upon so perilous an undertaking, although, with characteristic modesty, he declares that one soon accommodates one's self to such conditions and loses all sense of fear.

In his opinion most of the evils of the penal system, as it exists in Saghalien, are due to maladministration rather than to the defective state of the law. Its aims and provisions are not, on the whole, less humane than those of most civilized countries. But Saghalien is six thousand seven hundred and fifty-two miles from St. Petersburg. Consequently, anything like effective supervision and control of the local officials is impossible, and the chief hope of improvement lies in the appointment of men of a higher type. Some of them, of course, take a high view of their duties, and are just, considerate, and clean-living; but the lax morality, the peculation, the harshness, and the indifference of the majority to the moral and physical welfare of the prisoners may be held mainly responsible for the terrible conditions in which most of them drag out a precarious and miserable existence.

The other purpose that took Mr. Hawes to "the isle of the banished" was to reach the native tribes and put on record authentic information regarding their customs, traditions, and religious observances; and on all these points he has written in a most interesting and graphic manner. In addition to the Russians, he found five different peoples—namely, Ainus, Gilyaks, Orochons, Tungus, and Yakuts; but of the last-named there were only ten men and three women. It is probable that the Gilyaks came over from the mainland before the Orochons, attracted by the abundant hunting that the island then afforded; but be that as it may, Mr. Hawes ascertained that their traditions testify to their having found the Ainus already in possession. The latter, it has been conjectured, either came from Yezo, when the Japanese settlement drove them to that northernmost island of the empire, or the original emigration was from the mainland. The Ainus in Saghalien number about one thousand three hundred, and are settled in the southern portion of the island; but, greatly to his regret, our traveler was unable to visit them, inasmuch as he could find no means of transport, and the governor refused his permission. The Tungus, who are the best hunters, number about two hundred, the Orochons about seven hundred and fifty, the Gilyaks not less than two thousand; and it was to visit the two last-named tribes that Mr. Hawes undertook a fifty miles' land-journey from Alexandrovsk and a perilous six hundred miles' journey by river and sea in dug-out canoes to the then unexplored northeastern portion of Saghalien and back. The Orochons he found to be better hunters than the Gilyaks, and distinguished from them by the fact that they use their dogs only for hunting, while the Gilyaks use them for sledges, whereas for that purpose the Orochons use only reindeer. Many of them are still clad in fish-skins; but a sign that they have made greater advance than the Gilyaks may be found in their slicing their salmon and curing it over the fire in their huts, while the Gilyaks dry their fish in the sun, and thus are at the mercy of the weather for their store of winter food.

In appearance the Gilyaks resemble the North American Indians, but are short of stature as well as spare of limb, the men averaging five feet three inches, and the women some nine inches less. They are true children of the forest; agriculture is unknown to them, and for their living they are dependent upon fishing and hunting. Their year consists of six months, commencing in April and October. They have no written language, and the following legend to account for its loss is current in the tribe: "A Gilyak and a Chinaman were talking together upon the shore one day. The former was showing his books and letters to the latter, when most unfortunately a great wind arose, and blew away all the letters save five; and, to complete the great catastrophe, when the Gilyak's back was turned the Chinaman made off with the small remnant." News travels among them most rapidly in the mysterious way common to nearly all untutored tribes, and they have a tradition of a great flood which cut off the island from the mainland. Their religious rites are few and primitive. They believe in a future life, and worship as their chief deities the lords of the forest, sea, and fire, and the creator (or judge of right and wrong), before each of whom they must appear after death.

But even that land of moral darkness and abject misery—the home of primitive tribes and the prison of abandoned criminals—has not been left wholly without a ray of light. Some five years ago Miss Eugenie de Mayer, the daughter of a well-known Russian general and philanthropist, touched by their sad story and in the face of the greatest difficulties and hardships, left a wealthy home and all the social attractions of St. Petersburg to minister to the material and spiritual needs of the convicts. She has received encouragement and support from the highest quarters, and little though a single worker can do compared with the most piteous and pressing needs of twenty thousand convicts, it is wonderful how much she has accomplished. Her coming has been hailed with delight by the roughest of Saghalien's worst criminals; and as illustrating her courage and devotion and the ascendency she has already obtained over them, Mr. Hawes narrates the following incident. Unaccompanied by any of her sex, she went far into the interior with a gang of some two hundred convicts who had been sent under the charge of a handful of officers and guards to erect a telegraph-line through the primeval forest to a station in the south. One night as she lay in her small canvas tent she thought she heard voices, and on looking out, discovered two convicts, who, on seeing her, called out, "All right, lady; we are watching to see that you come to no harm." Even from the most hardened and abandoned some response may be expected to such devotion as Miss De Mayer's; and may her going to Saghalien on her work of good-will and mercy prove the dawn of a brighter day for the dreary isle of banishment!—Chambers's Journal.

PICTURES WITH ROMANTIC HISTORIES.

By CLIVE HOLLAND.

EVERY one must know the story of Gainsborough's "Duchess of Devonshire"; but scattered throughout the length and breadth of our land and the Continent are many pictures with histories almost as, and in some cases even more, romantic than that of the long-missing masterpiece.

In a Parisian picture-dealer's shop, one of those dark and gloomy depots in which are gathered some of the pathetic failures turned out by students and artists who have "gone under" or mistaken their vocation, with old oddments of armor, china, and *bric-à-brac*, lay hidden for nearly twenty years a Titian of immense value. Where the picture came from the dealer appeared to have but the faintest idea. As to its value he was, fortunately for the American amateur who unearthed the treasure, equally ignorant.

"It had been here years, m'sieu," he explained. "It was here when I took the business over from Monsieur B. You see, m'sieu," he further explained, "I am not a picture-dealer. One day a student—I think he was a *nouveau* at the Académie Julian in the Rue Fontaine—came in for a canvas upon which to paint. None of those I showed him were big enough. At last he caught sight of the picture in the far corner with its face to the wall. 'That's about the size,' he exclaimed. I told him it was much too dirty for his purpose, and so he went away, and the picture remained until Monsieur S. F. discovered it, and—I lost a fortune."

The old man died some years ago; but he seldom failed to drop a few tears from his somewhat over-red eyes at the thought. As for the picture, it was, at least until recently, in one of the magnificent private collections of America. It cost (cleaning, restoring, and carriage included) some two thousand dollars. It was valued by a famous Parisian dealer at forty-five thousand.

So recently as five and a half years ago a tourist tramping through Granada (Spain) came to a small village at the foot of the northern slope of the Sierra de Baza. The only inn was a wretched, tumble-down place with a sinister appearance. The September night was, however, fast closing in, and there was no choice. The mountain-road, at dusk, to the village on the southern side of the hills was not inviting, for brigandage had been somewhat rife. So, making the best of it, the artist, remembering that he possessed a revolver in case of emergency, applied at the inn for a night's rest. He was fairly well received, supper of a sort was hastily provided, and after the meal he sat near the wood-fire and smoked, for the night was a bit chill.

He must have fallen asleep, for he confessed that he woke with a start to find the room in almost complete darkness. But when the fire flickered up he saw two men crouching in a corner with his knapsack in their hands, evidently caught in the act of opening it. Whether it was fancy or not, the awakened sleeper thought that a third person was approaching him from behind, and that in the hand of one of the kneeling robbers he caught a gleam of naked steel. Anyway, he somewhat hastily drew his revolver from his pocket and jumped up. Within a yard or two of him stood a rough-looking peasant with a long knife drawn. It was not a moment for parley. The Englishman covered him with his revolver and called out to him to drop the knife. The man hesitated; and, seeing his companions were coming to his support, moral or otherwise, the artist deflected his revolver so as not to hit the man, and pulled the trigger. There was a sharp report, a crash of something falling, and a stampede of the would-be robbers.

The sound of the shot brought in the landlord and his wife, who in Andalusian patois, but with guilty faces, asked with assumed innocence what had occurred to disturb their guest. He explained somewhat forcibly. The landlord shrugged his shoulders, said he was very sorry, anathematized the robbers (who probably had been instigated to murder his stray guest by himself), and suggested that señor would perhaps like to retire to the upper chamber which had been prepared for him. The artist declined, and intimated his intention of sitting up all night where he was, and shooting any other persons than the landlord, his wife, or their daughter, a girl of about fourteen, on sight, should they enter the room. The night passed quite undisturbed save for the cackling of some fowls which seemed to be lodged in the next room, and in the early part of the night whisperings beneath the window.

When morning came the artist threw open the shutters, and at once noticed that the thing that had crashed to the floor when he fired the night before was an old picture which he had noticed hanging frameless on the wall. His bullet had severed the string. He took it to the window and examined it carefully. He thought he recognized the artist's work, although it was grimed with dirt and smoke. The wood on which it was stretched was injured, and as he stood examining it the woman came in and saw this.

"Señor," she exclaimed with well-simulated anger, "see what mischief your shot has done!"

The artist saw his chance. He expressed himself as being sorry.

"Sorry!" exclaimed the woman, thinking she saw a means of extortion; "but sorrow, señor, does not mend matters. We are poor people."

The woman's husband came in, and added his tale of woe to hers. In the end the man fixed a sum amounting to four shillings for the damage done to his wall and the picture. The artist declined, and the man finally insisted on his visitor paying a sum amounting to fifteen shillings and taking the picture.

As the artist made his way up the steep path toward the hill-road he heard the innkeeper and his wife rejoicing over their good fortune in selling a fool of a traveler a dirty picture for fifteen shillings. The artist carefully cut the canvas from its wooden stretcher, and also rejoiced, as well he might; for on reaching London he found he had brought away from the sunny South a Velasquez worth twelve hundred pounds to a dealer, to sell again!

Thirty years or so ago a picture with a strange history was purchased and removed from the Florentine palace in which for three or four centuries it had hung. It was by an unknown artist, but was undoubtedly painted with extraordinary skill. It was reputed to have the power of causing the death of any one who was unfortunate enough to be shut up alone with it for any considerable length of time. Tradition at least averred that its place originally was in a certain small chamber of the palace in which its sometimes barbarous and cruelly inventive lords were in the dark past in the habit of incarcerating "awkward" relatives or persons who had offended them.

The picture hung on the wall in only a moderate light, and depicted a most terrible maniac apparently in the throes of violent passion. Its realism was such that for fifty years before its sale the picture had been covered by a hanging curtain. It was horrible enough, but the true secret of its affrighting power was not revealed till it was being removed. It was then discovered that there was a large cavity behind the picture communicating with a stairway in the wall, and that the eyes of the maniac were painted on ivory disks which could be slid aside so that those of any one wishing to observe the occupant of the room could be inserted in their place! The same remark applied to the painted distorted mouth. The ivory disk could be slipped back and the lolling tongue (of which tradition spoke) be inserted by the person stationed behind the picture. One who saw the canvas ere its removal and disappearance stated: "It is conceivable that when real eyes rolling in their sockets and a real tongue lolling from the foaming mouth were added to the native horror of the unknown artist's conception and execution, any one of a highly sensitive or highly strung temperament might (as asserted) die of sheer terror."

What became of the picture there is no record. Possibly it was destroyed. Even how far its terrible record was true it is not possible to say. All that can be asserted with certainty is that its sinister uses seem borne out by documentary evidence, and that several persons are stated to have become mad while incarcerated in the palace in question during the sixteenth and seventeenth centuries.

There are several other stories of pictures somewhat similar in character to the foregoing. One of these is connected with a house in the suburbs of Paris, and dates from the early part of last century. In a large, old-fashioned house, in what was then an entirely rural suburb, dwelt an eccentric man who was stated to have been one of the gayest leaders of society at the court of the unfortunate Louis and Marie Antoinette. How he escaped the Revolution no one seemed to know; but in the first decade of the nineteenth century he took up his residence in the house in question with one servant, and there he lived almost a recluse till he died thirty years later.

All sorts of traditions grew up concerning him among the villagers, and one was of a mysterious picture which hung in the undusted, curiously furnished room which he chiefly occupied. All that seemed to be known was that it was "horrible," and that the one or two people he had insisted upon showing it to, as the price of their intrusion upon his solitude, had almost fled from the house in terror. No one had ever described the picture in detail; but the story went that it was a wonderfully powerful depicting of one of the most bloodthirsty and revolting incidents of the Reign of Terror.

One or two curious people had attempted to break into the house after the master announced his intension of living absolutely as a recluse; but if they succeeded in gaining an entrance, they failed to get a sight of the picture. On the death of M. Bisson it was thought that curiosity would be satisfied.

Nothing having been seen of either the old man or his servant for several weeks, the house was one day broken into by the authorities. Both were found dead in one of the upper rooms. The mysterious picture had disappeared from its frame, and whether it had been stolen or destroyed by its owner was never discovered.

For many years the house remained untenanted, so

evil was its reputation, and it was eventually pulled down, as no one could be found willing to occupy it.

At the time of the civil war in England many valuable pictures were destroyed or disappeared mysteriously—sometimes to turn up later on in most mysterious places. The greater portion of the collection of Van Dycks, Hobbemas, and portraits by Sir Peter Lely were taken from the gallery of a Buckinghamshire manor-house, an account of the looting of which by the Parliamentarian forces states: "Numbers of most excellent and valuable pictures were taken from the house, destroyed, or mutilated. Several paintings of women in lewde dresses or without garments were wrathfully slashed to ribbands by the orders of Colonel Wigginson."

What became of the majority of the canvases can only be a matter for conjecture; but in the early part of last century two Hobbemas and a very fine Van Dyck were discovered adorning the walls of one of the upper bedrooms of a Buckinghamshire farmstead.

Their discovery was interesting. For a period of some years previous the farmhouse had labored under the stigma of being haunted, and two antiquarian undergraduates from Oxford heard of the circumstance and decided to investigate the story. The room in which these three valuable paintings were carelessly hung upon the walls was the haunted chamber.

After a considerable amount of persuasion the undergraduates obtained permission to pass the night in the room, the maid-servant who usually occupied it having recently vacated it owing to the "ghost." The farmer's wife took the two young fellows upstairs; and after they had inspected the room, put down their haversacks, and asked a lot of questions, their attention was drawn to the three old paintings on the wall, two of which had but the remnants of frames. In reply to their inquiries, the woman told them that "the ole pickshurs had been there longer than she could mind, or her husband neither." One, she added, was quite "undecent" when she came there thirty-two years before as bride, but had luckily got so dirty and dusty that no one now could see what it was.

In the end the visitors became even more interested in the pictures than in the alleged ghost; and, failing to discover the spirit-visitor, eventually they carried off the three old paintings for "an old song."

One of the Hobbemas proved scratched and cracked almost beyond the powers of restoration, but the other was eventually bought, by the dealer who cleaned it, for six hundred pounds, the fine Van Dyck of a nameless court beauty bringing the fortunate ghost-hunters over fifteen hundred pounds.

It is seldom, one would imagine, that original paintings by celebrated artists are used to illustrate a book. But in one of the Amsterdam book-shops, about two decades ago, a folio miscellany was picked up by an English tourist, who was attracted by the water-color sketches which had been inserted therein as illustrations. Upon reaching home he placed the volume, which had cost him the equivalent of ten shillings, on a shelf, and forgot all about it for more than a couple of years; when, one evening, a neighbor who happened to be an artist dropped in for a game at whist, and after the rubber, Mr. S. suddenly, while talking of sketches, bethought himself of the book he had purchased. He took it from beneath a pile of other volumes in the cupboard where it had lain neglected, and handed it to his friend.

After a few minutes the artist said very quietly, "Have you any idea as to whether these drawings are any good?"

"No," replied the owner, "I don't know anything about them; but they took my fancy, and so I gave the man, after bargaining, ten shillings for the book."

The artist smiled. After a pause he said, "I will give you three times as much for the drawings, and you can keep the book."

"No," said his friend, "I don't want to sell."

"Well," said the other, "you are wise, for at least six of these sketches are by David Cox, and perhaps worth ten or even twenty guineas apiece. One is a Birket-Foster, worth about thirty pounds, I should say; and one is a Law, worth nearly as much. Two others I am doubtful about; the rest are not of much account."

The tourist placed the drawings in the hands of a well-known dealer; they were sold by auction, and altogether realized nearly three hundred and twenty guineas. One of the doubtful ones proved to be a Whistler, and the other a sketch for a picture by a well-known French artist.

Seldom has a famous painting ever descended to such base use as was the fate of a beautiful Rubens, which, after many vicissitudes, was eventually discovered lining the lid of a huge traveling-trunk offered for sale in Brussels. How long the picture had been tacked to the inside of the box-lid no one ever discovered; but although cut down and pierced in a score of places by coffin-nails, it was successfully restored, and the lucky purchaser of the box netted about three hundred pounds by the transaction.

In the dusty loft of a Normandy church remains, unless it has been removed during the last few months, what the present writer believes, as do two experts, to be a Raphael of considerable size and importance. Its discovery was made one sunny day in the late spring, when even the dust-laden loft of the church in question seemed less dreary than one might imagine. The roof of the church was reputed to be worth examination, and so we ascended the narrow stairway in company with a young priest who had spoken to us in the church below, and had offered to be our guide. After inspecting the roof we noticed in a fairly well-lit corner a pile of apparently old pictures, which, upon inquiry, we were told had been placed there many years before. Some were reputed to have come from a château hard by at the time of the Revolution, and others had been removed from their positions in the church many years previously, for what reason no one seemed to be quite clear. While the priest was talking to a companion we hastily fixed up a hand-camera we had, and "took" one of the pictures which seemed most interesting and to have a distinct appearance of being a Raphael or a work by one of his school. By rare good-fortune the negative, taken on a color-sensitive film, turned out very sharp and clear. A print from it has been submitted to experts, and the verdict is: "Probably a Raphael or a wonderfully good copy." Some day, when "fayre Normandie" calls from across the silver sea, we hope to spin along the white, straight, level road to ——— and bring to light the picture, whether Raphael or not.

BURKE'S OWN ACCOUNT OF THE SPONTANEOUS ACTION OF RADIUM ON GELATIN MEDIA.

The following is an abstract of the communication which was made to Nature by Mr. J. Butler Burke, of the Cavendish Laboratory, Cambridge, and which has given rise to so much sensational newspaper discussion:

"In the course of some experiments on the formation of unstable molecular aggregates, notably in phosphorescent bodies, I was led to try whether such dynamically unstable groupings could be produced by the action of radium upon certain organic substances. It will scarcely be necessary to enter here into an account of the many speculative experiments which I have at one time or another tried but it will suffice if I describe, as briefly as possible, the experiment which, among others, has led to a very curious result, and that is the effect of radium chloride and radium bromide upon gelatin media, such as those generally used for bacteria cultures.

"An extract of meat of 1 pound of beef to 1 liter of water, together with 1 per cent of Witter peptone, 1 per cent of sodium chloride, and 10 per cent of gold-labeled gelatin, was slowly heated in the usual way, sterilized, and then cooled. The gelatin culture medium thus prepared, and commonly known as bouillon, is acted upon by radium salts and some other slightly radio-active bodies in a most remarkable manner. In one experiment the salt was placed in a small hermetically-sealed tube, one end of which was drawn out to a fine point, so that it could be easily broken. This was inserted in a test-tube containing the gelatin medium. The latter was stopped up with cotton wool in the usual way with such experiments, and then sterilized at a temperature of about 130 deg. C. under pressure for about 30 minutes. Cultures without radium were also at various times thus similarly sterilized. When the gelatin had stood for some time and become settled, the fine end of the tube containing the radium salt was broken, from outside, without opening the test-tube, by means of a wire hook in a side tube. The salt, which in this particular experiment consisted of 2½ milligrammes of radium bromide, was thus allowed to drop upon the surface of the gelatin.

"After 24 hours or so in the case of bromide, and about three or four days in that of the chloride, a peculiar culture-like growth appeared on the surface, and gradually made its way downward, until after a fortnight, in some cases, it had grown fully a centimeter beneath the surface. If the medium was sterilized several times before the radium was dropped on it, so that its color was altered, probably by the inversion of the sugar, the growth was greatly retarded, and was confined chiefly to the surface. It was found that plane polarized light, when transmitted through the tube at right angles to its axis, was rotated left-handedly in that part of the gelatin containing the growth, and in that part alone.

"The cultures showed no contamination whatever and no rotation. The test tubes were opened and microscopic slides examined under a twelfth power. Objects were observed which at first sight seemed to be microbes, but as they did not give sub-cultures when inoculated in fresh media they could scarcely be bacteria. The process of any of the sub-cultures after a month was extremely small, and certainly too small for a bacterial growth. It was not at all obvious how bacteria

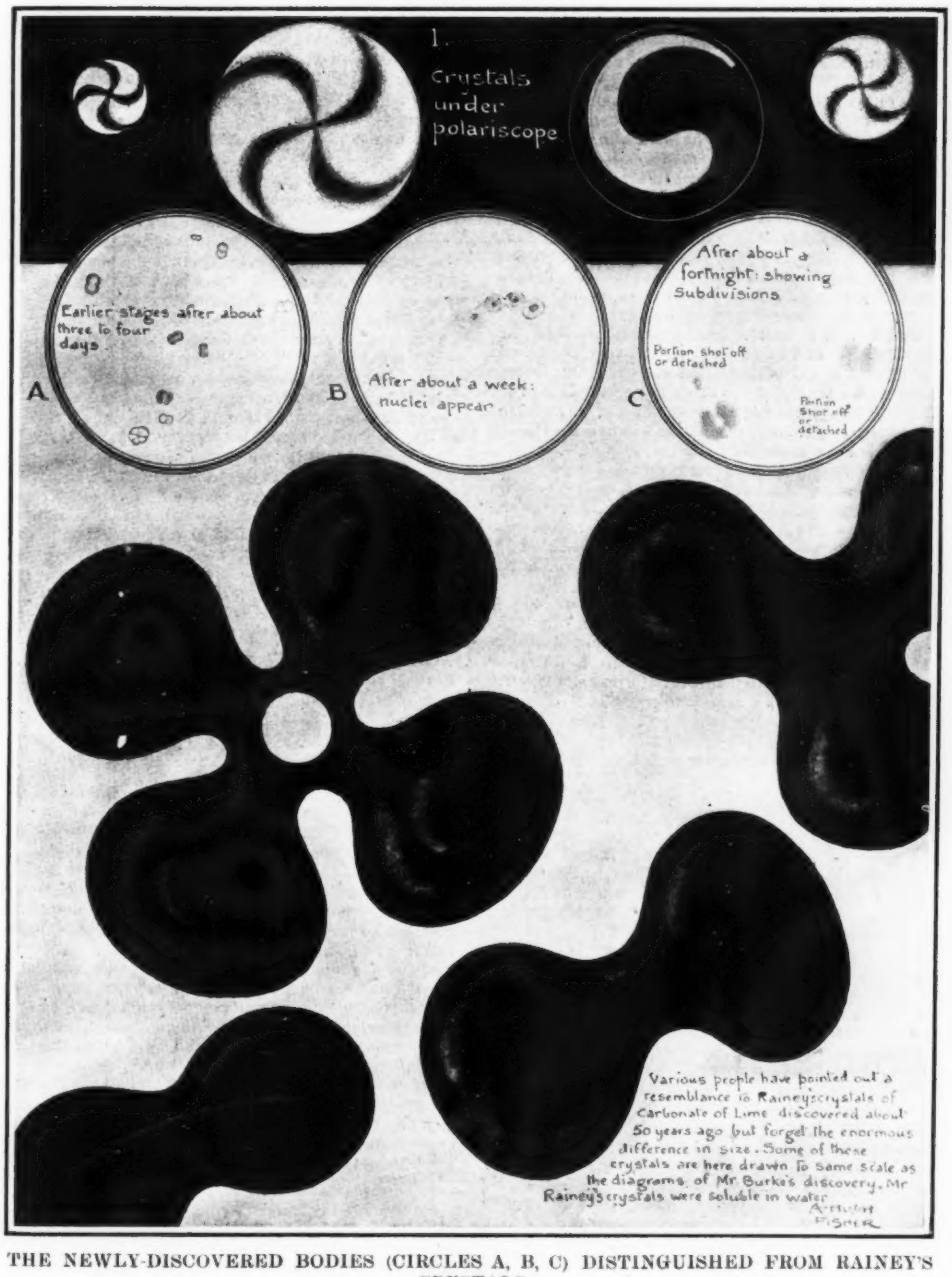
THE METHOD AND MATERIAL OF THE EXPERIMENTS THAT PRODUCED APPARENTLY LIVING BODIES IN STERILIZED BOUILLON.

could have remained in one set of tubes and not in the other, unless the radium salt itself acted as a shield, so to speak, for any spores which may originally have become mixed with the salt, perhaps during its manufacture, and when imbedded in it could resist even the severe process of sterilization to which it was submitted. On heating the culture and re-sterilizing the medium, the bacterial-like forms completely disappeared; but only temporarily, for after some days they were again visible when examined in a microscopic slide. Nay, more, they disappeared in the slides when these were exposed to diffused daylight for some hours, but re-appeared again after a few days when kept in the dark. Thus it seems quite conclusive that whatever they may be, their presence is at any rate due to the spontaneous action of the radium salt upon the culture medium, and not alone to the influence of anything which previously existed therein. When washed they are found to be soluble in warm water, and however much they may resemble microbes, they cannot for this reason be identified with them, as also for the fact that they do not give sub-cultures as bacteria should.

"Prof. Sims Woodhead has very kindly opened some of the test-tubes and examined them from the bacteriological point of view. His observations fully confirm my own. He assures me that they are not bacteria, and suggests that they might possibly be crystals. They are, at any rate, not contaminations. I have tried to identify them with many crystalline bodies, and the nearest approximation to this form appears to be that of the crystals of calcium carbonate, but these are many times larger, and, in fact, of a different order of magnitude altogether, being visible under comparatively low powers; and are, moreover, insoluble in water. A careful and prolonged examination of their structure, behavior, and development leaves little doubt in my mind that they are highly organized bodies, although not bacteria. Unfortunately, the quantity is so very minute that a chemical analysis of their composition is extremely difficult. The amount of salt in the first instance is so small, and the number of aggregates, or whatever they may be, thus produced perhaps still smaller.

"Photographs, together with the numerous results of eye observations, indicate that a continuous growth and development take place, followed by segregation. The stoppage of growth at a particular stage of development is a clear indication of a continuous adjustment of internal to external relations, and thus suggests vitality. They are clearly something more than mere aggregates in so far as they are not merely capable of growth, but also of sub-division, possibly of reproduction and certainly of decay.

"I have ventured, for convenience, in order to distinguish them from either crystals or microbes, to give them a new name, *radiobes*, which might, on the whole, be more appropriate as indicating their resemblance to microbes, as well as their distinct nature and origin. Some slightly radio-active bodies appear also to produce these effects after many weeks. A more detailed account of these experiments will be published shortly. This note merely contains some of the principal points so far observed."



THE NEWLY-DISCOVERED BODIES (CIRCLES A, B, C) DISTINGUISHED FROM RAINEY'S CRYSTALS.

THE HOME OF THE PIGMIES.*

By REV. REGINALD A. GATTY, LL.B.

THE object of this article is to stimulate research, and to show how the veriest amateur may in his small way contribute to the sum of scientific knowledge. An old earthwork was the first object which started my zest after archæological investigations, and I very soon acquired the one requisite in all such work—a quick and observant eye. It is surprising how blind many people are, and how little they see what is before their very eyes. I remember asking a friend who had recently returned from a tour round the world what had struck him most when he was in Japan as regards the scenery of the country, and especially the trees and flowers; but none of these had attracted his attention, and all he could remember was that the hotel at Tokio was not equal in its cookery to the accommodation he got at San Francisco. These people hardly deserve the privilege of such an opportunity of improvement as a tour round the world.

The faculty of observation is not sufficiently developed in our educational system; and I believe that when I taught the children of our village school how to pick up flint arrow-heads and scrapers in the ploughed fields they got more good than from plodding hours over fractions. I had previously taught myself; for, when the land was ploughed round the earthwork I have mentioned, I set to work to find some traces of the former people who had raised this mound of soil. The answer quickly came in a nice series of flint implements, such as knives, arrow-heads, scrapers, and other neolithic tools.

It may be well, perhaps, to make a few remarks about what is called the stone age, as every one has not taken the trouble to read the scientific books upon the subject. Whether man was resident in Britain prior to the glacial epoch is a matter of some doubt, and it would be of little use to repeat here the various opinions upon this open question. What we do know for certain is that in a very remote period a terribly cold time supervened, changing a temperate climate to one of arctic severity, and covering all North Britain with an ice-sheet extending almost to the Thames valley. In the north of Scotland the ice was as much as three thousand feet in thickness. It gradually moderated in thickness as it extended south; but the greater part of England at that time was practically within the arctic regions. This fully explains why up in the north of England palæolithic implements are never found. No life was possible so long as this ice-sheet covered the land, and neither man nor beast could possibly have lived under such severe conditions.

In the south of England, however, appear the earliest traces of man in the river-drift. Here in the gravels of former river-beds are seen the first rude implements of his handiwork, and these are remarkable for their great size. It certainly must have required a hand of no mean grip to grasp the heavy tools of flint six to eight inches long, which, when compared with the small neolithic tools, have the appearance of belonging to a race of giants.

We have, however, to remember that man at that period had to contend with animals of great size and power. The mammoth would be no mean antagonist to face in the forest, and the grizzly bear, hyena, and cave-lion would require some formidable attacks to drive them from the caves which man might wish to shelter in. But there is certainly a remarkable difference between a large palæolithic implement weighing a pound or two in weight and several inches in length, and one of the minute tools I am writing about, sixty of which when put into the scale weigh under half an ounce.

Considering that all palæolithic implements are found in river-drifts or cave-deposits, they rarely come under the observation of the amateur collector. His work must principally be confined to searching ploughed fields and barren places where the flint implements of the neolithic period occur in plenty. The neolithic or new stone age followed the palæolithic or old stone age; but between the two is an interval which as yet has not been clearly defined, and it is impossible to show the connection between the two eras.

A new race apparently had taken the place of the makers of the big, rude tools, and the forms and working of the neolithic tools show a marked improvement in every way. The old fauna and flora had disappeared, and animal life and vegetable life were pretty much the same as we see them now. Neolithic man domesticated animals, grew cereals, and lived in settlements on the land, moving, no doubt, from place to place as the pasturage became exhausted. This nomadic existence perhaps accounts for the distribution of flint implements, which is very remarkable. A search in almost any part of England over land which has been ploughed and well washed by rain will be rewarded by a find of flint implements. You need not live in a flint district to prove this. In fact, a flint is much easier to detect when no other stones of similar character are near it, and you may be sure each piece, even if not a true implement, has been imported.

For instance, in my own experience on the moors of South Yorkshire, high up on the Pennine Range of hills, I found splendid examples of neolithic flint tools, but the nearest flint-beds were the Yorkshire wolds, sixty miles away at least. It is difficult to imagine what the inducement could have been in this bleak and desolate region to tempt neolithic man to leave the richer valleys below and face the cold and exposure on the moors. Clad in skins, and with only a rude hut to shelter him, and little game to hunt for food, he could have had but a cheerless existence. He may have been forced to take refuge here by an invasion of a stronger tribe driving him out from his home on the lower grounds, or it is possible that a better climate existed on the moors in those times than we have now. There certainly are indications of a forest having existed on these moors, and sometimes when digging has been going on among the peat the horns of *Bos longifrons* have been discovered.

It was here, at an altitude of a thousand feet above sea-level, that I found the first minute flints which I called pigmy on account of their size. This was more than twenty-five years ago; but I could not get the authorities on flint implements to allow that they were genuine tools.

A more interesting discovery than mine was made by Dr. Colley Marsh of Rochdale, who, on the same Pennine Range, at an altitude of thirteen hundred feet, dug ten feet down into a peat-bed, at the bottom of which he found quantities of these pigmy flints associated with ordinary neolithic tools. Here was abundant proof that the makers of these small flints had once lived upon these moors of the Pennine Range, and from finding ordinary flints with them it would be a fair surmise to say the makers of these were also

* Chambers's Journal.

makers of the pigmy flints. Against this, however, is the fact that in only very few places in England have these minute tools been discovered.

In Belgium, M. Pierpont found pigmy flints with no other flints near them. In India, up in the cave-shelters of the Vindhya Hills, Mr. Carlyle found the floors thickly strewn with these same tiny implements, and he brought some thousands back with him to England. In the account he gave of his discovery he states that no large tools were associated with them.

The presence of various types in one locality is no sure proof that they were contemporary; and so far I think the evidences are in favor of crediting the pigmy-flint makers with being a distinct race. At any rate, my own experience supports this idea, and the discoveries I made in North Lincolnshire are so extraordinary that I think there is little doubt about the matter. I know this is not the opinion of the highest authorities.

The British Museum has brought out a new "Guide to the Stone Age," a most valuable book, and beautifully illustrated. This authority says, speaking of the Rochdale pigmy flints: "These minute and finely chipped specimens of characteristic crescent, triangular, and rhomboidal forms are often called 'pigmy flints,' and are found in India, Palestine, Egypt, North Africa, southern Spain, France, Belgium, and in several sites in Great Britain, notably in eastern Lancashire, Scunthorpe in Lincolnshire, Sevenoaks, and Hastings. The curious persistence of the same forms in all these countries has led to the conjecture that they are the work of one and the same race; but the same argument might be used to prove that the barbed stone arrow-heads of Europe, Japan, and North America were the productions of a single people. However it may be explained, the similarity of form is sufficiently striking to deserve careful attention. Various conjectures have been made as to the use of these implements, which are manufactured from small flakes, the natural edges being in most cases left untouched, and the thicker sides or backs carefully finished by secondary chipping. Some have supposed that they were tied to the points of arrows, others that they formed lateral barbs of harpoons, others that they were tattooing instruments, others that they were fish-snags, others again that they were used for making holes in skins or even harder substances like shell. The last suggestion seems to be borne out in the case of the small points found in South Spain, as diminutive shell-disks were found in association with them, but we need not assume that their use was in every case uniform, for very few show any signs of wear. The pigmy implements are usually assigned to the neolithic and early bronze periods."

Now, the use of the arrow-head, which is universal and absolutely necessary for the support of human life, is hardly a fair implement to bring into the argument when you are dealing with tools so difficult to assign uses for as pigmy flints. It is quite allowable to say the necessities of man developed the arrow-head in all parts of the world. It is simply a point for piercing, to which in some cases, but not in all, is added a barb on the two sides to prevent it from falling out.

On the other hand, there are at least four varieties of these pigmy tools, perfectly distinct in form and make, to which no reasonable use can be assigned. To give Mr. Carlyle's designations, they are (1) the shouldered pigmy flint, (2) the rounded and pointed, (3) the crescent, (4) the rhomboidal form.

It is utterly impossible to trace the slightest difference between those forms found in India and those in England, and this fact has led the Rev. Canon Greenwell to write the following opinion: "I can say without the least hesitation that the pigmy flints are manufactured articles, and brought into certain shapes to adapt them to certain purposes. I can also confidently assert that many show evident and abundant signs of having been in use. The next matter about which I can speak with perfect confidence is the fact that flint or some other stone implements, fabricated after the same fashion and characterized by the same forms, have been found not only in several localities in England, but also in Belgium and other places in Europe, and in very great abundance in India. In fact, so similar are many of the pigmies found in India to those found at Scunthorpe, Lakenheath, etc., that but for the differences of material, any one on seeing them would say without hesitation that the Indian specimens had been picked up at Scunthorpe. Nor do I think it possible—though I do not now speak so confidently as I have already spoken about their being manufactured—that they could have originated among different peoples who had no intercourse or traffic going on between them. A common intelligence, a common purpose, a common material could not, I think, produce forms so marked, and indeed peculiar, as are found among these tools. What the relationship, intercourse, or traffic I have suggested may have been I know not, but that there was a connecting link I believe."

I have, however, further if not stronger evidence than the words of the learned antiquary I have just quoted. It was my good fortune to drop on what I may call the home of the pigmies. Scunthorpe in Lincolnshire not many years since was a small agricultural village, and the land about it had little value, for it was mostly sand, and there were great commons on which practically nothing grew, for the never-resting wind blew the sand to and fro, and the bracken fern and some heather seemed the only plants able to contend with it. Then a discovery was made that beneath the sand, the depth of which in some places was twenty feet, a valuable bed of ironstone existed, and the little village rapidly became the center of a thriving iron-smelting industry. The process of obtaining the ironstone is simple enough. The sand is dug away and the ore bared, and then a fresh surface of land is laid out, which grows better crops than it did before.

A curious feature about the sand is that it is all æolian, the result of great sandstorms in the past, and not a marine or lacustrine deposit. On the high parts of the common the wind is perpetually altering the contour of the ground, raising and leveling mounds, according to the direction in which it blows. It will be readily understood that such a place, with its changing surface, would be very suitable for the discovery of flint implements if they were there, and I soon had the satisfaction of finding that it had been the site of human habitation in neolithic times. In various directions I found patches of charcoal and signs of hearths, and here and there flakes of flint lying about just as they had been struck off from the flint cores. In more than one place was a heap of cremated bones, and the wind one day exposed what is called an incense-cup. This is a small hearth-baked pottery vessel, about three inches high, with holes in the side.

Canon Greenwell, in his work "British Barrows," describes these vessels, and as to their use, suggests that they contained the lighted charcoal which was carried in the ceremonial accompanying cremation. He gives a note describing the funeral of an Indian, Narayan Wasudeo, a member of the Legislative Council of Bombay: "The sacred fire, which had been kindled with due ceremonies at the house, was carried in front in a brazen vessel by the deceased's son. While this (the making of the funeral pyre) was being done, a number of torches of sandal-wood were being carefully ignited by the son of the deceased at the sacred fire which he had brought with him for the purpose. The friends, when the torches were lighted, set fire to the combustibles." The extract is taken from the Times of India, September 1, 1874.

This touch with India is suggestive, but I must own I was perfectly astonished when I found pigmy flints identical with Mr. Carlyle's Vindhya Hill specimens strewn about in all directions. It is true I came across every now and then an ordinary neolithic flint implement; but the pigmies so largely predominated that they hardly counted. This proved that these Anglo-Indian tools had been made on the spot, for in one place, among a lot of flakes of a peculiarly colored flint, I found a pigmy of the same material. But if the Vindhya Hill specimens were small, the Scunthorpe pigmies were much smaller. When compared with the Indian tools, the respective sizes are as follows: the smallest Indian shouldered form is ten-sixteenths of an inch; smallest Scunthorpe, three-sixteenths of an inch; smallest Indian rounded and pointed, ten-sixteenths of an inch; smallest Scunthorpe, four-sixteenths of an inch; smallest Indian crescent, eight-sixteenths of an inch; smallest Scunthorpe, six-sixteenths of an inch.

With regard to the respective quantities found of pigmies and ordinary neolithic tools, I think it would be fair to say that while collecting two thousand Anglo-Indian pigmies I have got fifty neoliths. It is impossible in an article of this character to describe the exquisite work upon these minute flints. They are covered with delicate flaking, but how this was produced it is impossible to say. When you take up such a mite as one measuring three-sixteenths of an inch it disappears between finger and thumb. How was this held so as to enable the workman to take flakes off it? Flint is a very hard substance; and though you can by pressure remove flakes from it, you have to exert very considerable force. In the case of the Indian pigmies this must have been more difficult, for all of them are made of chalcedony or agate, which are still harder substances to work. Among the Scunthorpe pigmies I found a few chalcedony specimens.

It must not be supposed that every visit paid to the home of the pigmies results in a rich capture of spoil. The wind plays the principal part, covering or uncovering as it pleases. In a high wind you can see nothing. The sand whirls around and above you, fills your eyes, and I have been compelled to lie flat down and cover my head like a camel in a sandstorm.

I often ask myself, what is the meaning of this discovery, and what does it suggest? Before I addressed the Anthropological Society in London I was warned to state facts, and not to speculate. This may be very wise counsel, but it leads nowhere. The "Guide to the Stone Age," recently published by the British Museum, offers no solution of the problem; but I think it would be unfair to my readers if I closed this paper without expressing my own views. From the top of the common, where the flints are found, you can see a few miles away the broad stream of the Humber, where the Trent joins it. If a migration from India took place in neolithic times, one could imagine the rude vessel of those days being rowed up with the tide, and disembarking its strange occupants near to where they could take up a position on the high ground. It is true the sandy and almost waterless common would offer poor accommodation and means of support; but we need not suppose they remained there for any great length of time. I have shown that they moved on, at any rate, as far as the Pennine Range, and no doubt traces of them would be met with in other directions if people nowadays only used their eyes more. It requires, I know, sharp sight to detect a pigmy flint even when you have merely a sandy floor to deal with. It is doubly difficult on ploughed land.

The next question is, what kind of people were these makers of pigmy flints? Were they a small race, the progenitors of the myths of dwarfs and fairies which delighted us in our childhood days? Perhaps it would be unwise to follow this line of speculation any further. If I did I should certainly meet with very severe treatment at the hands of the scientific authorities. I have the satisfaction of knowing that what is a mystery to me is equally a mystery to them, and I live in hope that some day the blowing sand will uncover the secret of the home of the pigmies.

CONTEMPORARY ELECTRICAL SCIENCE.*

PROPERTIES OF RADIUM IN MINUTE QUANTITIES.—A. S. Eve deals with Voller's recent assertion that any radium preparation, when minutely subdivided and distributed over a large area, loses its activity in a few days. He shows that this would controvert all hitherto accepted views of the considerable permanence of radium radiation; and would leave the occurrence of radium in pitchblende an unsolved enigma. He supposes that the disappearance of the activity is only apparent, the falling off being due, not to the decay of the radium, but to its disappearance off the plate on which it is deposited. To decide the matter, he deposited the dilute preparation, not on a plate exposed to air, but on the inner surface of a closed flask containing a gold leaf electrometer. Voller found that 10^{-6} milligramme, distributed over 1.2 square centimeters, completely disappeared in 26 days. In the author's experiments more than 40 days elapsed since the maximum was reached, and there was no trace of disappearance, although the same amount was spread over 76 square centimeters. In a note added to the paper, E. Rutherford puts forward the supposition that the radium preparation does not adhere to the surface, but is easily blown off. Probably any other substance so minutely subdivided would behave in the same manner, only we cannot detect it unless it is radio-active.—A. S. Eve, Philosophical Magazine, May, 1905.

SOLAR ECLIPSE OBSERVATIONS.—The total eclipse of August 30 will be extensively utilized for special electric and magnetic observations. J. Elster and H. Geitel suggest that an attempt should be made to determine the ionization of the atmosphere during and immediately after the eclipse. The cone of the moon's shadow will intercept the ultra-violet rays, which are mainly effective in producing ionization. Their efficacy does not as a rule perceptibly affect the sea-level atmosphere owing to the opacity of air for ultra-violet rays. But some effect might be perceived, especially if the station is at a high level. Owing to the shortness of the time available, observations should not take longer than one or two minutes. It will be necessary to distinguish two effects, viz., the decrease in the number of ions and the decrease in their mobility which might be produced by the temperature falling to the dew point and weighting the ions. The Canadian government is sending an expedition to Labrador and the Prussian government to Burgos in Spain. Magnetic observations will be made at Cahirciveen in Ireland and at Ponta Delgada. Exner electron counters will be largely used for determining the number of ions.—Terrestrial Magnetism, March, 1905.

GAMMA-RAYS OF RADIUM.—E. Rutherford and H. T. Barnes have measured the heating effect due to the γ-rays of radium with a view to testing whether these rays are, as Paschen supposes, electrons projected with enormous velocity, or impulses akin to Röntgen rays. The former supposition acquired some color by Paschen's observation that over twice the heat could be got from a radium preparation by stopping the very penetrating γ-rays than could be got by stopping the γ-rays alone. The great speed of the electrons would account, to some extent, for their apparent non-deflection by a magnet, since their effective mass would be increased by the high velocity. The authors have, however, found that their previous surmise was correct, and that the γ-rays do not consist of projected particles. Instead of an ice calorimeter, which Paschen himself acknowledges to be inadequate for the small quantities of heat to be measured, they used a differential air calorimeter connected to a U-tube containing xylene, and arranged the apparatus so that the preparation could be surrounded by lead or aluminium in quick succession. It was found that the heating effects of the β and γ-rays was insignificant, and that practically the whole of the heat could be traced to the bombardment of the α-rays or positively-charged atoms.—Rutherford and Barnes, Philosophical Magazine, May, 1905.

ELECTRIC DEMONSTRATION OF THE EARTH'S MOVEMENT IMPOSSIBLE.—P. Langevin shows that Lorentz's hypothesis of a contraction of all matter in the direction of motion completely accounts for the negative result of Trouton and Noble's condenser experiment of 1903. Lorentz supposes that each unit of length in the direction of motion is reduced to $\sqrt{1-\beta^2}$, where β is the ratio of the velocity to the velocity of light. This hypothesis can be applied to the earth's motion if we assume that cohesion is an electromagnetic property of bodies. According to Trouton and Noble, a charged condenser suspended by a fiber should turn its plates parallel to the direction of the earth's motion. Now, according to Larmor, Lagrange's function, $W_e - W_m$ or the difference between the electric and magnetic energies of a system, must be a maximum or minimum in a state of equilibrium. When the system is in motion this equilibrium is disturbed, but not if there is the contraction of Lorentz's hypothesis. The new function will be

$$L' = L\sqrt{1-\beta^2}$$

and this is strictly independent of the orientation of the system. There is, therefore, no couple tending to turn the condenser. Hence Trouton and Noble's experi-

* Compiled by E. E. Fournier d'Albe in the Electrician.

ment must give a negative result at every degree of approximation, and for all forms of suspension.—P. Langevin, Comptes Rendus, May 1, 1905.

ELECTRICAL NOTES.

New Arc Lamp.—The Technische Woche announces the appearance on the market of a new arc lamp called Bébé, which works with continuous current, either as a monophotal (constant current) lamp, on system of 110 to 250 volts, or mounted in series with a second lamp, on system of 220 to 250 volts. In the latter case the two lamps, which are mounted directly on the system, are incandescent, and are regulated for an average intensity of about 1.5 amperes, each consuming nearly 120 volts, and giving with the exposed arc an average spherical intensity of about 150 Hefner candles. The consumption of carbon is so slight that the Bébé lamp can burn for 10 or 12 hours. When its lower carbon is used, it is put out of circuit automatically. The cost price is low, and the expense of its working is half that of incandescent lamps.

Electric Light and Vision.—A correspondent of the Journal für Gasbeleuchtung, while experimenting to ascertain whether it is possible to secure better results by previously heating the air in which the voltaic arc of an electric arc lamp is formed, met with a peculiar accident. In an attempt to heat the air previously, he extracted the filament of a carbon and introduced illuminating gas in the canal formed in the carbon. Studying closely the phenomenon produced, he spent more than two hours in observing the voltaic arc with the naked eye without experiencing anything abnormal. Suddenly he lost his sight entirely for ten minutes and recovered it just as suddenly. He then immediately went into a dark cold room and resumed his experiments after the lapse of a quarter of an hour. Twelve hours afterward his eyes commenced to water and quiver. He was under the special care of an oculist for a fortnight. For a considerable time now his eyes have remained extremely sensitive to any bright light.

All who have charge of electrical machinery know the troubles which are caused by a "flat" on a commutator. No brush of carbon will keep in touch with a commutator should a flat form upon this, unless the pressure upon the brush is too heavy. Heavy brush pressure means friction and wear. An interesting account appears in a recent number of the Electrical Times on the truing-up of a commutator. It was done by providing in the first place a pinion to gear into the barring notches of the flywheel, the ratio of the pinion to the wheel being 1 to 6.6. The pinion was machine-molded, and a worm-wheel on its shaft ran in an oil-trough, the worm being on the shaft of a pulley driven by belt from a 6-horse-power motor. The connecting rods of the engine were removed, and the turning tool was fixed to a slide-rest temporarily arranged, the tool being brought down to cut at the center line of the commutator. Two cuts were taken right across the face of this, the latter cut being very fine. The commutator was 38 inches diameter and 10 inches wide, and the turning removed weighed 18 pounds, or at the rate of about 2 pounds per square foot of area of commutator surface. The depth removed would thus be a trifle over 1/32 inch. The final finish was done by three grades of emery-cloth and glasspaper with the engine under steam at half-speed. So trued, a commutator is trued by the center of its own shaft, and ought to last well.

In big new countries the commercial conditions are rather inclement from a printing-telegraph point of view, and in the old European countries the growth of the telephone has reduced printing telegraphy to a question of saving labor. This question of saving labor by means of printing telegraphy is a very curious problem and far more intricate than is generally realized even by telegraph men. A few of the difficulties may be briefly explained, and for this purpose we must first distinguish between press and commercial messages. Press messages are long, and generally go to a number of centers. They can be handled in bulk under conditions specially favorable for saving labor by machine telegraphy. In fact, it is certain that within a few years press messages will be handled almost entirely by automatic machinery. With commercial messages, on the other hand, it is a physical impossibility to effect any great saving of labor by machine telegraphy compared with the simple Morse key and sounder. The messages are short, only about twenty words each, and there is no long straight-ahead run of work. It is like a train stopping at every little wayside station. At every twenty words the operator has to stop to sign and time the message, lay it aside, and start on another. At the receiving station, if it is a tape printing telegraph, the attendant has to cut up the printed tape and paste it on telegraph forms, and he must sign and time the messages and check the number of words. If it is a page-printing telegraph, then at the end of every twenty words a fresh telegraph form has to be fed in from a roll, and time must be allowed for the typewriter carriage (or its equivalent) to return to the beginning of each new line. These operations only occupy one or two seconds each, but when they have to be repeated every twenty words the aggregate loss of time is astonishing. If to these small delays we add the losses of time caused by mistakes, corrections, repetitions, and line disturbances, to say nothing of occasional breakdowns of the printing machinery and stoppages for adjustment of telegraph instruments, and last, but not least, the fact that the dear public does not send its telegrams in a nice continuous stream, but in gushes, and in a great rush during the three or four hours round about midday, it will be realized that the path of the printing telegraph inventor who aspires to save labor on the handling of commercial telegrams is distinctly precipitous. The amount of work that must always be performed by the human being in connection with commercial telegrams is large in proportion to the amount of work that can be performed by a machine.

ENGINEERING NOTES.

Employment of Iron Alloys in Germany.—A notable change has recently occurred in the use of ferro-silicium by the various steel works. While low percentages of this alloy have hitherto been principally in demand, now the higher percentages are employed. The twenty-five per cent ferro-silicium has been found too infusible for direct working, while the fifty per cent alloy is a porous structure and can be pulverized. For the ferro-chrome employed for manufacturing armor plates, it is said that the Krupp works are now using crucible ovens, and not electric ovens.

A series of interesting experiments, the object of which is to determine the maneuvering and reversing capacity of vessels fitted with the Parsons turbines, are to be carried out by the Fairfield Shipbuilding and Engineering Company, of Glasgow. The vessels selected for the tests are those built by the company for the Newhaven and Dieppe cross-channel service. Posts are to be erected at prescribed distances on the shore of the River Clyde, along the course of the measured mile at Skelmorlie. At these points data will be secured for estimating the deceleration and acceleration of the vessel at the reversing of the turbines. These tests are of especial interest, owing to the fact that the British Admiralty has ordered the turbine cruiser "Amethyst" to undergo a series of trials, in order to determine the stopping and turning powers of the turbines.

Under the old rule-of-thumb methods of road building one sort of rock was supposed to be as good as another. Miles and miles of expensive roads have been built in a haphazard way, of any sort of material that was available, and many of such roads have "raveled" and gone to pieces almost as rapidly as they could be built. Since the establishment of the proper methods of testing and investigating these materials, there has been noticed a great improvement of roads. The most intelligent and progressive of the State highway engineers are availing themselves of the opportunities extended to them by the Department of Agriculture for studying and familiarizing themselves with the physical properties of the materials which they are about to use before risking the public moneys in expensive work.

There is urgent need of study of the important question of ventilation and lighting in farm barns. A recent investigation carried on by the Agricultural College of Wisconsin has shown that scores of costly barns, intended to house valuable blooded live stock, and on which thousands of dollars have been expended to secure perfect sanitary conditions, are a complete failure so far as ventilation is concerned; and that this lack of proper ventilation is causing serious increase in the spread of tuberculosis and seriously impairs the profits of feeding. Hundreds of farmers are delaying the building of barns because, while they realize the nature of the difficulty and the necessity for its remedy, they do not know how to accomplish it. It is a striking but admitted fact that we are so ignorant of the proper principles of barn ventilation that many of the costliest structures built in recent years have been the most defective in this regard.

One result of the recent naval conflict between the Russian and Japanese fleets in the Tsushima Straits is the revival of the use of nets and booms for the protection of large war vessels against torpedo attacks. The British Admiralty has received a lengthy and detailed report from its naval *attaché*, Capt. Pakenham, who was on board Admiral Togo's flagship "Mikasa" during the battle. In this report the employment of the net is emphasized strongly. Although all British battleships and cruisers were originally provided with torpedo nets and booms placed entirely around the vessels, subsequently, however, the gear was removed from the cruisers, though it was retained in connection with battleships. This decision was due to the belief that the cruisers owing to their greater speed would prove far more effective if unhampered by torpedo nets. But the Japanese declare from the results of their experience that cruisers equally require this protection, and are quite as helpless as the battleships if deprived thereof. Any retardation in speed or hampering in maneuvering that may result from their utilization is more than counterbalanced by the element of safety that their use insures. The nets are consequently to be reinstated on the British naval vessels, though a modification in the arrangement is to be carried out. Hitherto the nets and booms have been carried on shelves placed about 25 feet above the water, but these shelves are now to be placed at a much lower level. Furthermore, the time of eight minutes which has been allowed for dropping the nets and booms into position is to be appreciably reduced. The Admiralty is also profiting from the experience of the Japanese in regard to fire control stations upon warships. This arrangement proved invaluable during the battle to the Japanese officers. These stations are elevated platforms built around the masts, and resemble enlarged fighting tops. They are provided with the latest types of range finders, and with telephonic communication to the various batteries. Two stations are carried on each ship, one controlling the forward batteries, and the other the after batteries, with officers contained therein to instruct the gunners as to range and elevation, etc.

TRADE NOTES AND RECIPES.

The Oesterreichischer Acetylen-Verein, a union of Austrian acetylenists, has adopted the following rules for the purchase of carbide. The receivers must be staunch, to preserve the carbide from air and moisture, and sufficiently firm to satisfy the transportation companies. The quality of a good commercial carbide should be such as to yield at least 300 liters of gas per kilo, at the temperature of 15 deg. C., under a pressure of 760 millimeters. A carbide yielding 270 liters may be accepted, but discount proportionate to the deficit should then be required; less than 270 liters should be unqualifiedly rejected. Granulated carbide (having grains of about one centimeter in diameter) should conform to the same conditions. Ten per cent of the smallest pieces may be accepted. For the analysis of carbide a person designated by the two parties takes out a sample, which is sealed on the arrival of the merchandise.

A correspondent of the Inland Printer gives the following method of marking steel tools as that adopted by a large house in the trade: "We first have a rubber stamp made with white letters on a black ground; then we make up an ink to use with this stamp as follows: Ordinary resin, ½ pound; lard oil, 1 tablespoonful; lampblack, 2 tablespoonfuls; turpentine, 2 tablespoonfuls. Melt the resin, and stir in the other ingredients in the order given. When the ink is cold it should look like ordinary printers' ink. Spread a little of this ink over the pad and ink the rubber stamp as usual, and press it on the clean steel—saw blade, for instance. Have a rope of soft putty, and make a border of putty around the stamped design as close up to the lettering as possible, so that no portion of the steel inside the ring of putty is exposed but the lettering. Then pour into the putty ring the etching mixture, composed of 1 ounce of nitric acid, 1 ounce of muriatic acid, and 12 ounces of water. Allow it to rest for only a minute, draw off the acid with a glass or rubber syringe, and soak up the last trace of acid with a moist sponge. Take off the putty, and wipe off the design with potash solution first, and then with turpentine, and the job is done."

If one were to ask most amateurs what they considered the most common defect in their negatives, no doubt the majority (says a writer in the Photo Beacon) would answer that pinholes gave them the most trouble. The writer is acquainted with several amateurs who have tabooed certain makes of plates solely because they thought that there were more pinholes in them than in other brands. These "punctures" have various causes—dust settling on the plate either before exposure or before development, air-bubbles in the gelatine film, and only recently some writer has told us that they are caused by fungous growths, which seem to thrive in gelatine emulsions. But the principal cause, especially of the large and most troublesome ones, is the formation of air-bubbles on the surface of the gelatine during development, which prevents the chemicals from acting on that part over which they lie. It seems that the gelatine holds a certain amount of air in its substance, which, when the plate is immersed in the developer, tends to rise to the surface of the film when it is softened, and remains there in the form of minute bubbles.

Now, the remedy for this is obvious. With a soft brush or wad of cotton go carefully over the surface of the gelatine once or twice after it has been softened slightly, and you will find that your troubles from pinholes will be reduced to a minimum. Care must be taken, however, to avoid scratching the gelatine with too stiff a brush.

Varnish for Bronze Articles.—The following process yields a top varnish for bronze goods and other metallic ware in the most varying shades, the varnish excelling, besides, in high gloss and durability. Fill in a bottle, pale shellac, best quality, 40 grammes; powdered Florentine lake, 12 grammes; gamboge, 30 grammes; dragon's blood, also powdered, 6 grammes; and add 400 grammes of spirit of wine. This mixture is allowed to dissolve, the best way being to heat the bottle in the water bath until the boiling point of water is almost reached, shaking from time to time until all is dissolved. Upon cooling decant the liquid, which constitutes a varnish of dark red color, from any sediment that may be present. In a second bottle dissolve in the same manner 24 grammes of gamboge in 400 grammes of spirit of wine, from which will result a varnish of golden yellow tint. According to the hue which is desired, now mix the red varnish with the yellow variety, producing in this way any desired shade from the deepest red to the color of gold. If required, dilute with spirit of wine. The application of the varnish should be conducted as usual, that is, the article should be slightly warm, it being necessary to strictly adhere to a certain temperature, which can be easily determined by trials and maintained by experience. In order to give this varnish a pale yellow to greenish-yellow tone, mix 10 drops of picric acid with about 3 grammes of spirit of wine, and add to a small quantity of the varnish some of this mixture until the desired shade has been reached. Picric acid is poisonous, and the keeping of varnish mixed with this acid in a closed bottle is not advisable, because there is danger of an explosion. Therefore, it is best to prepare only so much varnish at one time as is necessary for the immediate purpose.—Technisches Zentralblatt.

SCIENCE NOTES.

"Physical science is one and indivisible. Although for practical purposes it is convenient to mark it out into the primary regions of physics, chemistry and biology, and to subdivide these into subordinate provinces, yet the method of investigation and the ultimate object of the physical inquirer are everywhere the same."

The new education must reach the farmer in terms of the whole man—his particular business, his home and its ideals, his relation to good roads, good schools, the church, to social forces, to all that makes up a broad and satisfying country life. We must give attention to the ideals of living, as well as to the ideals of farming. The sanitation of the farm home, the architecture of the buildings (what silent and effective teachers buildings are!), the reading, the character of the farmyard, the questions associated with the bringing up of children, the social and commercial organizations—these are the kinds of subjects that the rising educational impulse must attack.

Perhaps no plant and its products are used in so many ways and for so many purposes as the grapevine and its fruit. Many of these uses are of ancient origin, owing no doubt to the fact that few plants grow and thrive under climatic and soil conditions so varied or respond to care and attention more generously than does the grapevine. Thus, we find certain forms of it in the natural state aspiring to overtop the mightiest monarchs of the forest and single plants overspreading areas hundreds of feet in circumference, while other forms are grown under cultivation as mere bushes, 2 or 3 feet in height, yet yielding crops ranging from 1 1-3 tons to as much as 22 tons of the finest fruit to the acre.

The British Museum has recently acquired a fine specimen of the sea-perch species, which has hitherto been absent from the national colection. The fish measures 4 feet 2 inches in length, and weighs 70 pounds. It was caught off the coast of Cornwall. This species was described and figured by Brito Capello in 1867 as *Serranus cernioides*, from the coast of Portugal. Although placed by Day in the synonymy of *Serranus gigas*, it differs therefrom as well as from *Epinephelus aeneus* in several important characters. The fish is pinkish brown in color, without any markings except a very faint dark streak from the eye to the angle of the præoperculum. The fins are dark purplish at the base, and blackish at the end. The tips of the pectoral, ventral, and caudal fins are white, while the iris is pale golden in hue.

The cultivation of the grapevine was the highest achievement of ancient husbandry, the vine and olive being, in antiquity, the marks, and almost the symbols, of settled and cultured life. Profane history does not reach back to the first plantings or the first wine made from the grape. It is interesting to note that grape seeds have been found with the remains of Swiss and Italian lake dwellers, in European graves of the Bronze Age, and in the tombs of the Egyptian mummies. The vine is frequently the subject of metaphor in the Scriptures—to dwell under vine and fig tree is emblematic of happiness and peace. We enjoy the grape in the fresh state, or, when dried, in the form of raisins or "currants;" the unfermented juice and wine are important items in household economy and medicine, while from the grape many other products and by-products are made. The vine itself gives pleasure to the senses by its fragrant blossom, beautiful foliage, and luscious fruit; it affords shade and shelter; various parts of it are employed for divers medicinal purposes; and the wood is used for fuel and in the manufacture of furniture and other useful articles. In fact, there is no part of the vine or its fruit that has not proven of value for one or more purposes.

The castor plant is one of the most interesting in the world's flora. Tropical in its origin, the antiquity of its culture is attested, first, by seeds found in the sarcophagi of the ancient Egyptians, and, later, by records of the utility of the plant in the earliest writings of the Hindus. Indigenous either to Africa or India, it has been carried by the many migrations of men in the course of ages to all parts of the tropical and subtropical world. The remarkable beauty of its foliage has also led to its culture as an ornamental plant far north of where it can be raised for industrial uses. A perennial in tropical climes, it grows to a height of 30 or 40 feet, but acclimated in cooler zones it becomes an annual, and attains a height of only from 8 to 12 feet. From the botanical, as distinguished from the cultural, point of view it is now widely distributed over all the warmer regions of earth. In our own possessions it grows wild in Porto Rico, is cultivated for oil to a small extent in Hawaii, and is also found in the Philippines. Cultivated in Mexico, there is official record of an increase of the crop from 57,000 bushels in 1900 to 327,000 bushels in 1902. The plant grows wild in many parts of South America, notably in Paraguay and Argentina, and a small export trade in castor beans is carried on from Brazil. It is cultivated in a small way in southern Europe, in northern and central Africa, and eastward, in about the same latitudes, grows sometimes wild, sometimes under cultivation, in Arabia, Persia, and, in fact, in most of the warmer countries and islands of the Oriental world. The botanical distribution of the plant, however, has little economic significance. In few countries does its cultivation give rise to even a small international trade in its products, and in none, except Mexico, are there statistical records of yield.

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